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Sirpa Kleemola and Martin Forsius (eds)

10th Annual Report 2001

UN ECE Convention on Long-range Transboundary Air Pollution

International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems

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Photo: A view from an intensive vegetation monitoring plot in the Hietajärvi monitoring site.
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Contents

Summary

Background and objectives of ICP IM

Integrated monitoring of ecosystems means physical, chemical and biological measurements over time of different ecosystem compartments simultaneously at the same location. In practice, monitoring is divided into a number of compartmental subprogrammes which are linked by the use of the same parameters (cross-media flux approach) and/or same or close stations (cause-effect approach).

The International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (ICP IM) is part of the Effects Monitoring Strategy under the UN ECE Convention on Long-Range Transboundary Air Pollution (LRTAP). The main objectives of the ICP IM are:

- Monitor the biological, chemical and physical state of ecosystems (catchments/plots) over time in order to provide an explanation of changes in terms of causative environmental factors, including natural changes, air pollution and climate change, with the aim to provide a scientific basis for emission control.

- Develop and validate models for the simulation of ecosystem responses and use them (a) to estimate responses to actual or predicted changes in pollution stress, and (b) in concert with survey data to make regional assessments.

- Carry out biomonitoring to detect natural changes, in particular to assess effects of air pollutants and climate change.

The full implementation of the ICP IM will allow ecological effects of heavy metals, persistent organic substances and tropospheric ozone to be determined. A primary concern is the provision of scientific and statistically reliable data that can be used in modelling and decision making.

The ICP IM sites (mostly forested catchments) are located in undisturbed areas, such as natural parks or comparable areas. The ICP IM network presently covers about 50 sites, with on-going data submission, in 21 countries. The international Programme Centre is located at the Finnish Environment Institute in Helsinki. The present status of the monitoring activities is described in detail in Section 1 of this report.

A manual detailing the protocols for monitoring each of the necessary physical, chemical and biological parameters is applied throughout the programme (Manual for Integrated Monitoring 1998).

Recent assessment activities within the ICP IM

Assessment of data collected in the ICP IM framework is carried out at both national and international levels. Key recent tasks regarding international ICP IM data have been:

- Input-output and proton budgets
- Trend analysis of bulk and throughfall deposition and runoff water chemistry
- Assessment of biological data using multivariate gradient analysis
- Dynamic modelling and assessment of the effects of different emission / deposition scenarios
- Assessment of concentrations, pools and fluxes of heavy metals

Conclusions from recent international studies

Input-output and proton budgets

Ion mass budgets have proved to be useful for evaluating the importance of various biogeochemical processes that regulate the buffering properties in ecosystems. Long-term monitoring of mass balances and ion ratios in catchments/plots can also serve as an early warning system to identify the ecological effects of different anthropogenically -derived pollutants, and to verify the effects of emission reductions.

The first results of input-output and proton budget calculations were presented in the 4th Annual Synoptic Report (ICP IM Programme Centre 1995) and the updated results regarding the effects of N deposition were presented in Forsius et al. (1996). Data from selected ICP IM sites were also included in a European study for evaluating soil organic horizon C:N ratio as an indicator of nitrate leaching (Dise et al. 1998). Soil water fluxes for budget calculations have been estimated using a water balance model (Starr 1999). New results regarding the calculation of fluxes and trends of S and N compounds have been presented in a scientific paper prepared for the Acid Rain Conference, Japan, December 2000 (Forsius et al. 2001).

The budget calculations showed that there was a large difference between the sites regarding the relative importance of the various processes involved in the transfer of acidity. These differences reflected both the gradients in deposition inputs and the differences in site characteristics. The proton budget calculations showed a clear relationship between the net acidifying effect of nitrogen processes and the amount of N deposition. When the deposition increases also N processes become increasingly important as net sources of acidity.

A critical deposition threshold of about 8-10 kg N ha^{-1} a^{-1}, indicated by several previous assessments, was confirmed by the input-output calculations with the ICP IM data. The output flux of nitrogen was strongly correlated with key ecosystem variables like N deposition, N concentration in organic matter and current year needles, and N flux in litterfall. Soil organic horizon C:N-ratio seems to give a reasonable estimate of the annual export flux of N for European forested sites receiving throughfall deposition of N up to about 30 kg N ha^{-1} a^{-1}. Such statistical relationships from intensively studied sites could be efficiently used in conjugation with regional monitoring data (e.g. ICP Forests and ICP Waters data) in order to link process level data with regional-scale questions.

The reduction in deposition of S and N compounds at the ICP IM sites, caused by the new 'Protocol to Abate Acidification, Eutrophication and Ground-level Ozone' of the CLRTAP ("Gothenburg protocol"), was estimated for the year 2010 using transfer matrices and official emissions. Implementation of the new protocol will further decrease the deposition of S and N at the ICP IM sites in western and northwestern parts of Europe, but in more eastern parts the decreases will be smaller (Forsius et al. 2001).

Trend analysis

Empirical evidence on the development of environmental effects is of central importance for the assessment of success of international emission reduction policy. First results from a trend analysis of monthly ICP IM data on bulk and throughfall deposition as well as runoff water chemistry were presented in Vuorenmaa (1997). ICP IM data on water chemistry have also been used for a trend analysis carried out by the ICP Waters and presented in the 9-years report of that programme (Lükewille et al. 1997).

New calculations on the trends of N and S compounds, base cations and hydrogen ions have been made for 22 ICP IM sites with available data across Europe (Forsius et al. 2001). The site-specific trends were calculated for deposition and runoff water fluxes using monthly data and non-parametric methods.

Statistically significant downward trends of SO_4, NO_3 and NH_4 bulk deposition (fluxes or concentrations) were observed at 50% of the ICP IM sites. Sites with higher N deposition and lower C/N-ratios clearly showed higher N output fluxes, and the results were consistent with previous observations from European forested ecosystems. Decreasing SO_4 and base cation trends in runoff waters were commonly observed at the ICP IM sites. At some sites in the Nordic countries decreasing NO_3 and H^+ trends (increasing pH) were also observed. The results partly confirm the effective implementation of emission reduction policy in Europe. However, clear responses were not observed at all sites, showing that recovery at many sensitive sites can be slow and that the response at individual sites may vary greatly.

Assessment of biological data using multivariate gradient analysis

The effect of pollutant deposition on natural vegetation, including both trees and understorey vegetation, is one of the central concerns in the impact assessment and prediction. The first assessment of vegetation monitoring data at ICP IM sites with regards to N and S deposition was carried out by Liu (1996). Vegetation monitoring was found useful in reflecting the effects of atmospheric deposition and soil water chemistry, especially regarding sulphur and nitrogen. The results suggested that plants respond to N deposition more directly than to S deposition with respect to vegetation indices.

De Zwart (1998) carried out an exploratory multivariate statistical gradient analysis of possible causes underlying the aspect of forest damage at ICP IM sites. These results suggested that coniferous defoliation, discolouration and lifespan of needles in the diverse phenomena of forest damage are for respectively 18%, 42% and 55% explained by the combined action of ozone and acidifying sulphur and nitrogen compounds in air.

From the present and previous ordination exercises it was concluded that the applied statistical techniques are capable of revealing underlying structure and possible cause-effect relationships in complex ecological data, provided that analysed gradients have an adequate range to be interpolated. Since the data obtained was unexpectedly poor in the span of environmental gradients, the results of the presented statistical ordination only indicated correlative cause-effect relationships with a limited validity. The poor span of gradients could be attributed to the relative scarcity of biological effect data and the occurrence of missing observations both in the chemical and biological data sets. It was concluded, that the power of the vegetation monitoring in impact assessment would increase considerably with improvements in the ICP IM data reporting and inclusion of additional sites.

A scientific strategy to carry out further data assessment of cause-effect relationships for biological data, particularly vegetation, has been developed within the ICP IM. This work is led by the National Focal Point of The Netherlands. A joint assessment of EU/ICP Forests Intensive Monitoring and ICP IM vegetation data is currently planned, see Section 3 of this report.

Dynamic modelling and assessment of the effects of emission/ deposition scenarios

In a policy-oriented framework, dynamic models are needed to explore the temporal aspect of ecosystem protection and recovery. The critical load concept, used for defining the environmental protection levels, does not reveal the time scales of recovery. Dynamic models have been developed and used for the emission/ deposition scenario assessment at selected ICP IM sites (e.g. Forsius et al. 1997, 1998a 1998b, Posch et al. 1997). These models are flexible and can be adjusted for the assessment of alternative scenarios of policy importance.

These modelling studies have shown, that the recovery of soil and water quality of the ecosystems is determined by both the amount and the time of implementation of emission reductions. According to the models, the timing of emission reductions determines the state of recovery over a short time scale (up to 30 years). The quicker the target level of reductions is achieved, the more rapidly the surface water and soil status recover. For the long-term response (> 30 years), the magnitude of emission reductions is more important than the timing of the reduction. The model simulations also indicate that N emission controls are very important to enable the maximum recovery in response to S emission reductions. Increased nitrogen leaching has the potential to not only offset the recovery predicted in response to S emission reductions but further to promote substantial deterioration in pH status of freshwaters and other N pollution problems in some areas of Europe.

At the 17th session of the UN/ECE Executive Body in December 1999 the importance of the monitoring and dynamic modelling of recovery was underlined. ICP IM participates in a joint coordinated exercise on dynamic modelling together with other ICPs. The National Focal Point of the UK is leading this modelling work in ICP IM. The work has strong links to projects financed by the Nordic Council of Ministers and the EU. Priority in the ICP IM work is given to site-specific modelling activities. Earlier model applications at the ICP IM sites give a good basis for the future activities.

Pools and fluxes of heavy metals

The work to assess concentrations, stores and fluxes of heavy metals at ICP IM sites has recently started. This work is led by the National Focal Point of Sweden. First results are presented in Section 2 of this report.

Future work

- Maintenance and development of a central ICP IM data base at the Programme Centre.

- Continued assessment of the long-term effects of S and N compounds to support the implementation of emission reduction protocols, including:
    - assessment of trends;
    - calculation of ecosystem budgets;
    - dynamic modelling and scenario assessment.

- Calculation of pools and fluxes of heavy metals at selected sites (continuation of the work).

- Assessment of cause-effect relationships for biological data, particularly vegetation (continuation of the work).

- Coordination of work and cooperation with other ICPs, particularly regarding dynamic modelling (all ICPs), cause-effect relationships in terrestrial systems (ICP Forests, ICP Vegetation), and surface waters (ICP Waters).

- Cooperation with external organisations and programmes, particularly Global Terrestrial Observing System (GTOS) and International Long Term Ecological Research Network (ILTER).

- Participation in projects with a global change perspective. It is currently planned to use data from sites in the ICP IM network in the EU-project 'Carbon and nitrogen interactions in forest ecosystems (CNTER)', and in the project 'Climate induced variation of dissolved organic carbon in Nordic surface waters (NMDTOC)' of the Nordic Council of Ministers.

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ICP IM activities, monitoring sites and available data

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1.1 Review of the ICP IM activities in 2000-2001

Meetings

- Lars Lundin and Martin Forsius reported progress of the ICP IM programme at the meeting of the UN/ECE Working Group on Effects, Geneva, 23-25 August, 2000.

- Martin Forsius represented the ICP IM programme at the annual meeting of EU/ ICP Forest Intensive Monitoring programme, 20-21 September, 2000 (Heerenveen, The Netherlands).

- Programme Centre (Martin Forsius) participated in the UN/ECE expert meeting on dynamic modelling, Ystad, Sweden, 3-5 October, 2000. The scientific methodology for a joint exercise on dynamic modelling together with other ICPs and related projects was discussed.

- ICP IM (Martin Forsius and Lars Lundin) was represented at the Acid Rain Conference in Tsukuba, Japan 11-16 December 2000. A scientific paper 'Fluxes and trends of nitrogen and sulphur compounds at Integrated Monitoring Sites in Europe' was prepared, and will be published in Water, Air and Soil Pollution. Lars Lundin presented a poster about the ICP IM programme.

- ICP IM (Martin Forsius and Lars Lundin) was represented at the Extended Bureau meeting of the Working Group on Effects 12-14 February 2001 in Geneva.

- The ninth meeting of the Programme Task Force on ICP Integrated Monitoring was be held in Rome, Italy, 3-4 May, 2001. A one-day workshop of the ICP Integrated Monitoring was held prior to the Task Force meeting on 3 May.

Projects, data issues

- A representative of the Programme Centre (Martin Forsius) participated in an evaluation project of the Integrated Monitoring programme carried out in the Baltic countries. The project was funded by the Nordic Council of Ministers, and the main aim was to assess the benefits of the investments of the Council in establishing Integrated Monitoring in these countries. Michael Starr (Finland) was the project leader and Sven Bråkenhielm (Sweden) was the third member of the evaluation team. The evaluation report was published in autumn 2000.

- Programme Centre participated in the EU project 'Networking of Long-term Integrated Monitoring in Terrestrial Systems (NoLIMITS)', contributed to the building of a pilot meta-database, and was represented in the NoLIMITS Task Force. The final reports from the project were published in autumn 2000, and are available at http://nolimits.nmw.ac.uk/.

- Data from selected sites in the ICP IM network are used in the EU RECOVER:2010 project (coordinator, R. Ferrier, UK), and in a related project of the Nordic Council of Ministers (coordinator R. Wright, Norway). The aim of these projects is to study regional-scale recovery from acidification of surface waters.

- Meta data from sites in the ICP IM network were submitted to GTOS database.

- The Programme Centre finalized the new ICP IM database and software for the reporting of 1999 data.

- After October 1st 2000 the National Focal Points (NFPs) reported their 1999 results to the IM Programme Centre. The Programme Centre carried out standard check up of the results and incorporated them into the new IM database.

- Laboratories participating in the ICP IM Programme took part in the intercomparison test 2000 organized by ICP Waters and in the intercomparison test 2000 organized by EMEP.

Scientific work

Scientific work regarding four priority topics has continued:

- Calculation of pools and fluxes of heavy metals at selected sites (led by the NFP of Sweden). IM Programme Centre has assisted in compiling additional heavy metal data provided by the NFPs for this work. A technical report was presented for the ICP IM Task Force meeting 2001 (see Section 2) and the ICP IM contribution to a WGE report has been compiled.

- Assessment of cause-effects relationships for biological data, particularly vegetation (led by the NFP of The Netherlands). A joint assessement of EU/ICP Forests Intensive Monitoring and ICP IM data is currently planned (see Section 3).

- Calculation of fluxes and trends of S and N compounds, base cations and H^+ (led by the Programme Centre). A scientific paper prepared by the Programme Centre was presented at the Acid Rain Conference (December 2000, Tsukuba, Japan).

- Dynamic modelling (led by the NFP of the UK in cooperation with the Programme Centre). This work has strong links to projects financed by the Nordic Council of Ministers and the EU. ICP IM participates in a joint coordinated exercise on dynamic modelling together with other ICPs. Priority in the ICP IM work is given to site-specific modelling activities. Earlier model applications at the ICP IM sites give a good basis for this work.

Reports

ICP IM will produce the following reports to the meeting of Working Group on Effects, August 2001:

- Annual Report
- Contribution to summary report of the ICPs on the calculation of heavy metal pools and fluxes
- Contribution to Joint Report of the ICPs.

1.2 Activities and tasks prepared for 2001-2002

Activities/tasks related to the programme's present objectives

- Maintenance and development of a central ICP IM data base at the Programme Centre.

- Participation in inter laboratory comparisons organized by other ICPs.

- Inclusion of quality controlled national data for 2000 in the IM database.

- Processing of additional information (background info/site descriptions) for detailed assessments (e.g. dynamic modelling).

- Continuation of scientific work in the following four areas according to agreed scientific strategies:

  (i) Calculation of concentrations, pools and fluxes of heavy metals at selected sites.

  (ii) Assessment of cause-effect relationships for biological data (particularly vegetation).

  (iii) Assessment of pools, fluxes and trends of S and N compounds, base cations and H^+.

  (iv) Site-specific dynamic modelling and impact scenario assessment.

Activities/tasks aimed at further development of the programme

- Participation in the activities of external organisations, particularly Global Terrestrial Observing System (GTOS) and the International Long Term Ecological Research Network (ILTER).

- Participation in projects with a global change perspective. Data from sites in the ICP IM network will be used in the EU-project 'Carbon and nitrogen interactions in forest ecosystems (CNTER)', and in the project 'Climate induced variation of dissolved organic carbon in Nordic surface waters (NMDTOC)' of the Nordic Council of Ministers.

Activities/tasks to be carried out in close collaboration with other ICPs

- Dynamic modelling work according to strategy discussed at joint UN/ECE expert meeting on modelling. (Ystad, Sweden, 3-5 October, 2000).

- A joint assessment of EU/ICP Forests Intensive Monitoring and ICP IM vegetation data is planned (see Section 3). The ICP IM work is led by the NFP of the Netherlands.

- Continued assesement of trends in surface waters with ICP Waters.

1.3 Published reports and articles 2000/2001

Evaluations of international ICP IM data and dynamic model development

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1.4 Monitoring sites

The Integrated monitoring network covers the following twenty-one countries: Austria, Belarus, Canada, Czech Republic, Denmark, Estonia, Finland, Germany, Iceland, Ireland, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Russian Federation, Spain, Sweden, and United Kingdom. These countries have on-going data submission from at least one monitoring site. Switzerland has reported data from year 1997 and will make a new decision on the continuation and extent of IM activities in 2002. Netherlands has discontinued monitoring but has reported data from the year 1999.

Location of the IM monitoring sites with on-going data delivery are presented in Figure 1.1 (i.e. data from year 1996 received or continuation of the site confirmed).

1.5 Monitoring data

All in total, integrated monitoring data are at present available from 70 mostly European sites. An overview of the data reported internationally from sites with on-going data delivery to the ICP IM Database is given in Table 1.1. Additional earlier reported data are available from sites outside those presented in Figure 1.1. with on-going data submission. These sites have either been suspended or taken out of the IM network and used for regional monitoring. Presently the number of sites with on-going data submission is about 50.

Site with on-going data submission

Site with data submission to be started

Figure 1.1 Geographical location of ICP IM sites with on-going data delivery.

Table 1.1 Internatinally reported data from ICP IM sites with on-going data delivery (- subprogramme not possible to carry out, * or forest health parameters in former subprogramme Forest stands/Trees).

AREA	SUBPROGRAMME															*									
	AM	AC	PC	MC	TF	SF	SC	SW	GW	RW	LC	FC	LF	RB	LB	FD	VG	BI	VS	EP	AL	MB	BB	BV	Info
	meteorol.	air chemistry	precip. chemistry	moss chemistry	throughf.	stemflow	soil chemistry	soil water chemistry	groundw. chemistry	runoff water c.	lake water c.	foliage chemistry	litterfall chemistry	hydrob. of str.	hydrob. of lakes	forest damage	vegetat.	bioelem.	veget. structure	trunk epiphytes	aerial gr.algae	microb. decomp.	bird inventory	vegetation inventory	
AT01	95-98	95-98	97		97						-						93,99			93,98					
BY02	89-99	89-99	89-99				95-98			95-99															
CA01	88-96		88-96						88-96	88-96															
CH01	88-97	88-97	88-97		91-97				90-96	88-97	-	89			-	95-97									
CZ01	89-98	89-98	89-98	89	89-98					89-98	-				-										
DE01	90-99	90-99	90-99	90	90-99	90-99	90	90-99	88-99	90-99	-	90-99	90-98		-	90-99	90-95			92-95		94-99	91-96	90,95	
DK01			92-00		92		86	92-00		-	-			-	-										
DK02			97							97	-				-										
DK03			94-00		94-00		95	94-00		-	-			-	-		95								
EE01	95-99	94-99	94-99	94	94-99	94-99	94	94-99	95-96	-	-	94-99	94-99	-	-	94-95	94,97			94-96		94-99		94	
EE02	94-99	98-99	94-99	94-97	94-99	94-99	94-95	95-99	95-99	94-99	96	94-99	94-99			96-99	96			94-95	94-99	96-99			
ES01			92-93		92-93		92	92-93		91-93	-				-										modelling data
FI01	88-99	94-99	88-99	88-96	89-99	89-99	88-89	89-99		88-99	87-99	88-97	90-97		90-93	88-91	88-98			88-97		90	87-89	87	
FI03	88-99	93-99	88-99	89-96	89-99	89-99	88	89-99		88-99	87-99	88-97	90-97		90	88-91	90-98			90-97		90-91	87-89		
FI04	88-99	89-99	88-99	89-96	89-99	89-97	89	89-96		88-99	86-99	89-97	90-97			89-91	89-98			89-98		90-91	87-89		
FI05	88-99		88-99	91,96	89-97	89-97	88	89-96		89-99	87-99	88-97	90-97			88-91	89-98			89-97		90-91	88-89		
GB01	88-99	91-99	88-99				90		90-91	88-99	-				-										
GB02	88-99	91-99	88-99		88-91	88-91		90-91		88-99	-				-										
IE01			91-98		91-98	92-97		91-98				91-96	91-98												
IS01			97-99						98-99	97-99														96	
IT01	93-99	93-99	93-99		93-99	93-99	93-95	93-99		-	-	93-95		-	-	92-99				92		93			
IT02	77-99	93	93-99		93-99	93-99	93-95	93-99		-	-	93-95		-	-	92-99				92					
IT03	92-97	93-97	92-97		94-97	94-97	93,95	95-97		-	-	93,97	94	-	-	93-97	95			92					
IT04	92-97	93-97	92-97		94-97	94-97	93,95	95-97		-	-	93,95	94	-	-	93-97				92					
IT05	97	97	97		97	97	95			-	-	97		-	-	97									
IT06		97	97		97	97	95			-	-	97		-	-	97									
IT07	97	97	97		97	97	95			-	-	97		-	-	97									
IT08		97	97		97	97	95			97	-	97		-	-	97									

Table I.1 (continues) Internatinally reported data from ICP IM sites with on-going data delivery (- subprogramme not possible to carry out, * or forest health parameters in former subprogramme Forest stands/Trees).

AREA	SUBPROGRAMME														*									
	AM	AC	PC	MC	TF	SF	SC	SW	GW	RW	LC	FC	LF	RB	LB	FD	VG	BI	VS	EP	AL	MB	BB	BV	Info
	meteorol.	air chemistry	precip. chemistry	moss chemistry	throughf.	stemflow	soil chemistry	soil water chemistry	groundw. chemistry	runoff water c.	lake water c.	foliage chemistry	litterfall chemistry	hydrob. of str.	hydrob. of lakes	forest damage	vegetat.	bioelem.	veget. structure	trunk epiphytes	aerial gr.algae	microb. decomp.	bird inventory	vegetation inventory	
IT09	97	97	97		97	97	95			97	-	97		-	-	97									
IT10	97		97		97		95			-	-	97		-	-	97									
IT11		97	97		97		95			-	-	97		-	-	97									
IT12	97	97	97		97	97	95			-	-	97		-	-	97									
IT13	97	97					95			-	-	97		-	-	97									
LT01	93-99	93-99	93-99	93	93-98		93	94-99	93-99	93-99							93-99				93-98			93	
LT02	93-98	93-99	93-98	93	94-98		93	94-99	93-99	93-99	-			93-98	-		93-99			93-99	93-98			93	
LT03	95-98	95-99	95-99		95-98		94	95-99	95-99	95-99				95-98			94-99			94-99	94-98			94	
LV01	93-99	93-99	93-99	94,98	94-99	94-99	94-99	94-99	94-99	93-99	-	94-99	94-99	95-98	-	94-99	94-98			94-98		96-98			
LV02	93-99	94-99	93-99	94,98	94-99	94-99	94,99	94-99	94-99	93-99	93-98	94-99	94-99	95-98	95-98	94-99	94,97			94-98		96-98			
NL01	61-99	86-99	61-99	93-99	93-99	93-99	93,97	97	80-99	-	80-99	93-99	93-98	-	92-99	84-99				99			90-98		TF, SF also 82-84
NO01	87-99	87-99	87-99	92	89-99		86	89-99	87-88	87-99	-	86			-	91-99	86			86					
NO02	87-91	87-99	87-99	88	89-99		89	89-99		87-99	-	89			-	92-99	89								
PL01	88-96	88-96	88-96	88-90	93-96		88	93-96		88-96	88-95	88-90													
PT01	88-99	89-99	94-99							90-99	90-99														
RU03	89-94	89-98	89-98																						
RU04	89-94	89-98	89-98	90										93-99		93-99	93			93		94-96			
RU12	93-94	93-98	93-94																						
RU14	94	94-98	94-98																						
RU15	90-98	90	90-97	94	90-98	90-96	90		90-98	90-98	-			93	-		91			94					
RU16				89-90			89	89	89						93-99	93-96	91-94			89-94	93	94-95		91	
RU18			92-97	92	92-97	92-97	93	94-97	95-97	92	92-94	92				93	94			93		93			
SE04	87-97	88-99	87-99	95	87-96		95	87-88	79-96	87-96	-	99			-	97-99	95,98	91,95	91	96	92-98	95-99			
SE14	96-99	96-99	96-99	95	96-99			95-99	96-99	96-99	-	99	95,99		-	97-99	82-99	96		97	97-99	95-99			
SE15	97-99	96-99	96-99		96-99		97	95-99	97-99	96-99	-	97,99	95,99		-	98-99	96-99	98	98	98	97-99	95-99			
SE16	99	99	99		99					99		99					99	99	99						

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2 Progress report on the assessment of heavy metal stores and fluxes

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2.1 Introduction

Investigations on heavy metals (HM) is one of the prority topics of the ICP IM (see Section 1). This work is led by the National Focal Point of Sweden. The main focus of the work is on cadmium (Cd) and lead (Pb). Data on copper (Cu), nickel (Ni) and zinc (Zn) is available from nine sites while six sites report data also on arsenic (As), vanadium (V) and chromium (Cr). Intensive studies on mercury (Hg) have been carried out at two sites.

Information on heavy metal concentrations were provided from 29 sites with bulk deposition from 19 sites, moss chemistry from 22 sites, throughfall from 17 sites, stem flow, soil, groundwater and runoff from 10 sites, foliar and litter from 12 sites and on soils from 22 sites. Included in this report is Cd, Pb, Cu, Zn and to a small extent Hg.

Heavy metal concentrations in relevant environments are often below detection limit (dl), especially in water. Quality is assured by the procedures of the ICP IM manual. In the case of values below dl, the ICP IM procedure is to give a value half of dl, which would produce biased results. Values are often positively skewed which means that non-parametric statistical methods should be used. However, in this presentation the values rely on ordinary average and median calculations.

The degree of heavy metal retention in forest ecosystems is monitored as input and output from small well-defined catchments, according to the ICP IM method. Dry deposition should be included in the input, so that total deposition roughly equals throughfall plus litterfall, with internal circulation in the tree stand as an added term. Additional measurements in soil water and groundwater allocate the accumulation to various soil layers. For proper mass balance calculations transports have to be determined by use of hydrological soil models. WATBAL applied on ICP IM sites is an example of a simple easily used model. Unfortunately, heavy metal measurements have been optional in the ICP IM programme so data are not reported from all sites.

2.2 HM concentrations in water compartments

To calculate mean annual deposition concentrations, the amount of monthly precipitation gave the weight of each month and the total was summed up. This resulted in ranges of bulk deposition concentrations, sometimes agreeing well with EMEP estimations, sometimes less well, with most deviations for Pb. In the years 1996-98 the ICP IM stations reported concentrations in Cd of 0.01-0.8 μg/l, Cu of 0.8-4.4 μg/l, Pb of 0.5-9.5 μg/l, and Zn of 1-50 μg/l.

Bulk deposition concentrations in incoming rain at IM sites are influenced by the vegetation cover, especially the trees. The levels are thereby enriched by passage through the tree canopies by leaching of the leaves or needles. The following median concentrations were encountered in throughfall at different sites; Cd 0.07-0.7, Cu 0.9-7, Ni 0.6-8, Pb 2-10, Zn 6-68 μg/l. The origin of the leached metal is dry deposited pollution or derived from inner circulation. Fractions that are not leached will reach the ground when leaves or needles are shed.

Extensive measurements in soil water have been performed in IM sites of Finland, Sweden, Latvia and Poland. The following concentration ranges were found; Cd 0.07-1.3, Cu 0.24-5.4, Ni 6-12, Pb 0.26-27 and Zn 11-138 μg/l, all representing site median concentrations.

Ranges for runoff concentrations (site medians) at ten sites were: Cd 0.015-0.36, Cu 0.13-1.4, Ni 0.13-5, Pb 0.05-2 and Zn 0.4-14 μg/l, so metal exports from forested catchments certainly differ as a consequence of metal deposition or other factors.

2.3 Fluxes and retention

The input/output balance for Finnish and Swedish ICP IM catchments have been reported in scientific papers and national reports. There was considerable metal retention for Cd, Cu, Ni, Pb and Zn.; 80 to 95% of the total input. At some sites retention is somewhat lower for Cd and Zn, but even for these more mobile metals the general picture is ongoing accumulation in the system. Finnish plot scale budgets calculated for transports in soil water show that storage takes place in lower parts of the catchment, either in deep soil layers or in peatlands. This is a picture from a low deposition situation in forest landscape with large peat deposits in wet areas.

Although the hydrological soil model has not been applied for transport calculations to all sites yet, metal concentration profiles in soil water for a few sites in East Europe indicate relocation from upper soil layers to lower (Table 2.1). High metal levels may occur further down in the soil profile and in runoff water in some cases. These sites are subject to larger metal loads compared to Nordic sites. Soils are of similar podzolic types implicating similar processes at least in upland areas.

2.4 Soil stores

Soils have large capacity of heavy metal storage due to adsorption to organic material. The present soil stores have resulted from a long deposition history. Reduced deposition and relocation between soil layers by leaching in recent years have not had full impact yet. The following concentration ranges are encountered in humus layers of ICP IM sites; Cd 0.3-1 (even up to 3 at one site), Cu 5-23, Ni 0.6-8, Pb 13-160, Zn 23-100 μg/g. In mineral soil layers in the lower part of the rooting zone at a depth of 30-40 cm, the following concentrations occur; Cd 0.01-1, Cu 0.7-

21, Ni 2-24, Pb 4-46, Zn 3-85 $\mu g/g$. Especially for Pb, a major component of long-range air pollution, there is a pronounced allocation to humus layers. The same is the case for Hg although the ICP IM data is scarce.

Table 3.1 Aqueous heavy metal concentration profiles through selected catchments. Site median concentrations ($\mu g/l$).

	Cd	Cu	Ni	Pb	Zn
Lekuk, Poland					
Deposition	0.3	2.1	1.0	3.7	16
throughfall (spruce)	0.4	4.6	2.7	5.7	68
soil water 25 cm	1.3	5.0	9.8	27	52
soil water 50 cm	0.7	3.7	6.3	41	52
runoff water	0.4				
Rucava, Latvia					
deposition	0.2	1.3	0.6	3.7	19
throughfall (pine)	0.4	1.8	0.5	3.5	27
soil water 10 cm	0.2	0.7		6.0	33
soil water 20 cm	0.07	0.7		0.8	13
soil water 40 cm	0.03	0.5		0.2	7
runoff water	0.06	1.4		0.2	7
Aneboda, Sweden					
throughfall (spruce)	0.15	5.0	0.8	4.5	39
soil water 38 cm	0.3	0.6		0.5	30
runoff water	0.04	0.8	0.8	1.2	5
Valkeakotinen, Finland					
deposition	0.04	1.0	0.4	2.0	4
throughfall (spruce)	0.4	2.0	3.5	7.3	12
soil water 35cm					27
runoff water	0.02	0.3	0.5	0.5	4

2.5 Biological effects of HM

A main priority of the UN ECE Working Group on Effects is to develope dose - response relationships for priority pollutants. An interest on heavy metals has stimulated the biological research with mass balance calculations and critical levels shown at workshops organised by ICP MCLL. This has put a focus on the topsoil, the organic soil layer where HM are efficiently stored. High HM content inhibits basic microbial activity with decreasing decomposition of the organic material resulting in hampered turnover of nutrients. Last year, soil biological effects were compiled from literature at a workshop, but the values presented were provisional and need further elaboration. Especially the uncertainties at low concentrations have to be investigated experimentally. For such research ICP IM sites are most suitable.

Preliminary effect levels has been presented according to the *Precautionary principle*, rather than the *Maximum Acceptable Damage principle,* and gave the following ranges of total soil contents; Hg 0.1-0.25 mg/kg, Pb 10-40 mg/kg and Cd 0.1-0.4 mg/kg. The relevance of total content was discussed but should not be disregarded, though more bioavailible forms of the metals could have higher relevance. Information on such more bioavailable concentrations are, however, sparse.

Another HM impact, primarily related to mercury, is on surface water ecosystems. Mercury is of special interest to freshwater biology but information is very limited. From a few catchments there are determinations on total-Hg but the most bioactive phase of Hg, that is methyl-Hg, is rarely included in the monitoring. However, literature discussions on factors affecting release indicate a sufficient input of methyl-Hg from deposition (0.04-0.46 g km^{-2} a^{-1}), even if catchment manipulations and processes, together with climate, provide conditions for the turnover. Determinations on outflow of methyl-Hg from catchments to surface water are in the range 0.007-0.33 g km^{-2} a^{-1}. This has especial importance for fish.

2.6 Future work

The following activities are in progress:

- WGE report on heavy metals, for which the ICP IM part has been compiled.

- Technical report will be prepared during 2001. This report will include catchment/plot scale balance studies on sites, effects on vegetation, a chapter on data quality and a special chapter on mercury.

- Scientific paper on heavy metals, a draft will be presented to the ICP IM Task Force meeting 2002.

3 Progress report on modeling understorey vegetation at a continental scale

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3.1 Introduction

At the 1998 ICP IM Task Force Meeting in Tallinn, it was decided to put more emphasis on our ability to conduct biological effect studies. In order to accomplish this, the Task Force requested the Dutch delegation to develop a plan to further enhance our abilities in this field and to take the lead in defining and mobilizing the requirements. It was adopted to put a first focus on modeling the occurrence of understorey vegetation species (de Zwart 1999). After two calls for data in 1999 and 2000, it turned out that the ICP IM programme, with only 70 stations, in itself is not capable of providing the required data density to cope with statistical evaluation of species/environment relationships. In response to this conclusion, cooperation was sought and found with the Pan European Programme for Intensive Monitoring of Forest Ecosystems of the European Union (EU) and ICP Forests.

After informing the participants in the EU and ICP Forests networks in September 2000 of the plans for vegetation modeling, actions were taken to formulate a combined 3-year EU-project for cooperation between INRA in France as the lead party (Jean-Luc Dupouey), and Alterra (Han van Dobben with assistance from the FIMCI team (Gert-Jan Reinds and Wim de Vries)) and RIVM (Dick de Zwart) in The Netherlands. The project involves the exploration of both multi-variate gradient analysis and multiple regression techniques for relating biodiversity to the abiotic environment.

3.2 Project plan

The 3-year project cooperation between INRA, Alterra and RIVM is scheduled to accomodate the following phases:

- Year 1 2001: Database validation, preliminary data analysis and species and predictor selection. Progress reporting in ICP IM Annual Report and Forest Intensive Monitoring Technical Report.

- Year 2 2002: Formulation, calculation and validation of final biodiversity models, both species centered and community centered. Progress Reports updates.

- Year 3 2003: Final reporting to both parties.

The results of community centered analysis (multi-variate gradient analysis) and the species centered approach (multiple regression) will be analysed and compared to give a clue about the most appropriate predictors. The first type of analysis will be mainly performed by INRA and Alterra, whereas the second statistical method will be accomodated by RIVM. Frequent interactions seem to be essential.

3.3 Scientific context and project goals

At the European scale, ground vegetation composition is assessed or planned to be assessed in the near future on a large proportion of the Intensive Monitoring plots. In 2000, 864 plots had already been installed in the Intensive Monitoring network (De Vries et al. 2000) across Europe and ground vegetation investigations were carried out or planned to be carried out in a near future in 637 of these plots. In addition, a number of plots from the ICP IM (Integrated Monitoring) network may provide both physico-chemical and biological data. In the coming year, data integrity and the predictor selection need to be further elaborated. It is not yet certain that merging ICP IM data with the Intensive Monitoring data is the most appropriate way. It may be scientifically more sound to use the ICP IM data for validation of the models that are constructed with the Intensive Monitoring data.

Ground vegetation is a key parameter of long-term monitoring networks for three main reasons:

- It is the most important component of the total biodiversity of forest ecosystems. We should remember that plant diversity is mainly due to the presence of herbaceous or shrub species and mosses, trees being most often, in terms of species richness, only a small component of total species diversity. In temperate, Mediterranean and Boreal forests, the number of tree species is most often in the 1-10 range, whereas the number of species in the ground layer is in the range of 10-100. Diversity of species and probably of genes are thus much higher in the ground layer than in the tree layer. This is true at the plot level, but even more at the regional level: in the 9 French Intensive Monitoring plots of the Alps, for example, 14 species were found in the tree layer *versus* 323 in the herb and moss layers (Dobremez et al. 1997). As such, we must follow the changes in this species richness as they appear in time.

- Ground vegetation participates in the major processes driving forest dynamics, including element and water cycling or biotic interactions. Ground vegetation transpiration can equal or exceed tree layer transpiration, especially during drought in open stands. It can also surpass annual fluxes, in the forms of uptake from or return to the soil, of mineral elements in the tree layer. Finally, it competes strongly for light with tree seedlings during the first stages of their life. Thus, long-term changes in ground vegetation could have a significant impact on various forest ecological processes.

- Ground vegetation is a powerful bio-indicator of several environmental factors and of their spatial and temporal variations. It often gives precise and integrated information about soil nutrient and nitrogen status, soil acidity, water availability or climatic conditions (Ellenberg et al. 1991, Van Dobben 1993, Van Dobben et al. 1999). These relationships between vegetation and environmental factors could be used to get information about the global state of forest ecosystems and indirectly monitor their changes in time.

First results of atmospheric deposition monitoring in the Intensive Monitoring network show that nearly half of the plots receive more than 14 kg $ha^{-1}a^{-1}$ of nitrogen, and a quarter receive more than 16 kg $ha^{-1}a^{-1}$ of sulphur. Acid deposition is above critical loads for vegetation in 15% of the plots. Aluminium in soil solution has reached a critical level in 10 to 15% of the plots. Thus, vegetation could have already reacted to current environmental changes, including atmospheric deposition. Indeed, long-term changes of forest vegetation have already been reported in terms of both species richness and plant communities composition in several parts of Europe: The Netherlands (Van Dobben 1993), France (Thimonier et al. 1992, 1994), Sweden (Falkengren-Grerup 1995), Central Europe (Wittig 1992). These changes most often point toward an acidification and a nitrogen enrichment of forest ecosystems.

Intensive Monitoring plots will offer the opportunity of large scale analysis of long-term vegetation trends in a near future. The first round of vegetation sampling in Intensive Monitoring plots is now achieved, and data are available for a statistical analysis of vegetation-environment relationships. Such an initial analysis is interesting because:

- It is the necessary basis for future interpretation of temporal trends in vegetation composition, which will be possible within the next 5 to 10 years, when a second round will be achieved.

- It will bring new information about the main environmental parameters which control the distribution of forest plant species at the European scale. In this context, it should be already possible to quantify the specific role of atmospheric deposition, after partialling out the effects of bioclimatic, edaphic and sylvicultural stands characteristics.

- This analysis could allow us to identify gaps and limitations in the current sampling strategies used in Europe for vegetation monitoring.

3.4 Detailed project content

The project is organized in three steps :

- Assessment of simple vegetation characteristics, which is a prerequisite for the following steps.

- Evaluation of the relationships between environmental factors and vegetation communities as a whole.

- Evaluation of the relationships between environmental factors and selected individual species.

First step : Assessment of vegetation characteristics

Species features
An initial step will be the calculation of simple characteristics for each observed species : total frequency of presence in the European network, minimum, maximum and median cover values. The extent of the European distribution range will be assessed by calculation of simple parameters such as the maximum distance between plots where a given species is present. Such an analysis of species features will allow us to build a sublist of species which could be later used for an analysis of species-environment relationships at the species level. These species should be present over a sufficiently large distribution range with a sufficiently large range of cover values.

Biodiversity parameters
We will calculate simple attributes of plots : species richness (number of species, total or for specific guilds - by vertical strata, or for some functional groups if available -), species evenness and integrated coefficients such Shannon diversity index. (the biodiversity measures to be used will be evaluated by an expert group coordinated by P. Neville).

Ellenberg indicator values
A weighted average (using cover or presence/absence values) of Ellenberg indicator values for each plot wil be calculated. This will be done for the following indicator values: R : soil acidity, N : nitrogen availability, F : soil humidity, L : light, K : continentality and T : temperature (also maybe S : salinity)

Gradient analysis
The total set of plots will be analysed by classical direct gradient techniques (principal component analysis, correspondance or detrended correspondance analysis), in order to build synthetic indices for each plot (position of the plots along factorial analysis axes). Depending on the results of this first analysis of the total set of plots, subsets will be possibly identified by clustering procedure and subjected to a new round of direct gradient analysis. This division of the total set of plots will be necessary for further analyses if strong phytogeographic divisions appear between some groups of plots.

Second step : Relationships between vegetation characteristics and environmental factors at the plot level

In this step, the differences in species composition of the ground vegetation will be explained by differences in a variety of environmental factors. This type of analysis obviously requires estimates on a set of environmental variables, spatially and temporally corresponding to the plant inventories.

Environmental data required
In order to analyse the vegetation-environmental relationships, a complete set of environmental data for each plot is required:

Bioclimatic factors
- Where possible, main climatic parameters will be collected : annual and growing season temperature and rainfall and, more important, potential or actual evapotranspiration. A simple classification into large bioclimatic region will also be used.
- Plot elevation and aspect.

Edaphic factors

- Humus type and thickness.
- Soil type, depth, maximum water availability, density and chemical characteristics (pH, C, N, P, Ca, Mg, K, Al, CaCO3, base saturation, cation exchange capacity, heavy metals).
- Soil solution chemical characteristics (SO4, NO3, NH4, Ca, Mg, K, Al, pH, DOC).

Atmospheric deposition

- Chemical composition of bulk and/or throughfall deposition (mainly N-NO3 and N-NH4, Ca, Mg, K, S, pH).

Stand characteristics

- Dominant tree species, stand age, density and basal area, dominant height.

Spatial coordinates of the plots

All these data are already available in a number of plots. In other cases, they will be calculated from available European maps when possible.

Analysis of species-environment relationships at the plot level

Two kind of analyses will be undertaken : indirect or direct gradients analyses. In the former, vegetation characteristics previously calculated are *a posteriori* correlated with environmental factors. In the latter, environmental variables are included within the process of vegetation data analysis, by redundancy analysis or canonical correspondance analysis.

Indirect gradient analyses

Regression models will be built relating each of the previous vegetation characteristics, calculated at the plot level (parameters of species diversity, Ellenberg indicator values, position along factorial axes) to environmental factors collected on the same plots.

This step should allow the identification of the environmental factors which explain the largest part of the observed vegetation variability.

Direct gradient analyses

Redundancy analysis, canonical correspondance analysis or detrended canonical correspondance analysis will be applied to the vegetation-environment table (presence or cover values) in order to identify what is the part of the vegetation variability which can be explained by the environmental factors that are measured at the Intensive Monitoring plots or estimated from European maps.

The comparison between indirect and direct analyses will allow the quantification of the variability which cannot currently be explained by these environmental factors.

If needed, environmental factors other than atmospheric deposition will be first partialled out, and the residual variability analysed in a direct gradient analysis in order to specifically quantify the effect of atmospheric deposition.

Third step : Relationships between species presence or abundance and environmental factors

Taking into account results of the previous steps, the MOVE model (Latour & Reiling 1993, De Zwart 1999) will be applied in order to explain the occurrence of individual species of plants as a function of previously analysed environmental characteristics. This model is based on logistic regression of species occurrences or poisson regression of species abundance against a variety of environmental factors.

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4 Progress report on the assessment of fluxes and trends of S, N and base cations at ICP IM sites

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4.1 Introduction

The Programme Centre has been leading the biogeochemical work for assessing fluxes and trends of key compounds related to acidification effects and nitrogen processes at the ICP IM sites. A key activity during the last year has been the preparation of a scientific paper for the Acid Rain Conference, Japan, December 2000 (Forsius et al. 2001). The methods and results are presented in detail in this paper and are here only briefly summarised.

The aims of this study were to:

- Calculate input-output budgets of N and S compounds, base cations and hydrogen ions.
- Calculate site-specific trends for deposition and runoff water fluxes and concentrations using monthly data and non-parametric methods.
- Estimate the potential for future reductions in deposition of N and S compounds at the sites, caused by implementation of the new Gothenburgh emission reduction protocol.

According to availability of internationally reported data in the ICP IM database, 22 sites were selected for the analysis (Figure 4.1).

Figure 4.1 *Location of ICP IM sites included in the calculations of fluxes and trends.*

4.2. Methods

Fluxes for the budget calculations were calculated as the average of the last three years with available data in order to reduce yearly variability.

The trend assessment was performed mainly for the period 1988/89 - 1998. Time series with a minimum of five years monthly data were accepted for the statistical analyses. The trend analyses were done with the DETECT software package (Cluis et al. 1989), using non-parametric methods.

The effect of the new UN/ECE Gothenburg Protocol on S and N deposition at the sites was calculated with transfer matrices of the UN/ECE EMEP/MSC-W centre and reported official emissions (reference year 1996, target year 2010) (EMEP/MSC-W 1998).

4.3 Summarised results

- The relationship between N deposition and N output flux, and C/N-ratio and N output flux at the ICP IM sites seem to be generally consistent with established criteria (e.g. Dise et al. 1998) for assessing the risk of elevated N output fluxes (Figure 4.2).

- Statistically significant downward trends of SO_4, NO_3 and NH_4 bulk deposition (fluxes or concentrations) were observed at 50% of the ICP IM sites (Table 4.1).

- Implementation of the new Gothenburg emission reduction protocol will further decrease the deposition of S and N at the ICP IM sites in western and northwestern parts of Europe. The decrease in SO_4 deposition (-36 % on the average at all the studied sites) is expected to be larger than for NO_3 (-24 % on the average). Changes in NH_4 deposition are expected to be rather small at all the ICP IM sites.

- Decreasing SO_4 and base cation trends in output fluxes and/or concentrations of surface/soil water were commonly observed at the ICP IM sites (Table 4.1).

- At some sites in northern Europe decreasing NO_3 and H^+ trends (increasing pH) in surface/soil waters were observed (Table 4.1). An increasing trend in H^+ in runoff water observed at the Finnish site FI01 Valkeakotinen, is apparently caused by increasing concentrations of total organic carbon.

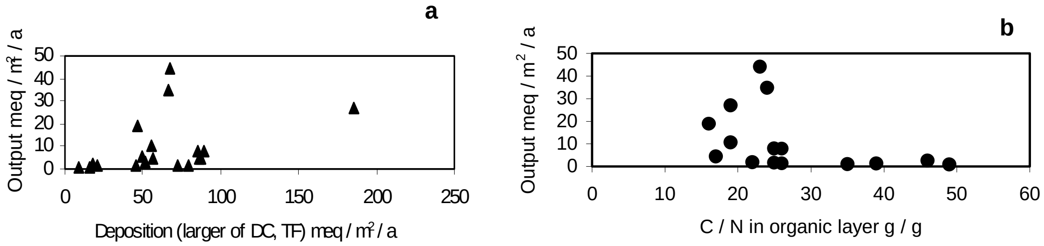

Figure 4.2 *The relationship between N deposition and N output flux (2a), and C/N-ratio of the soil organic matter and N output flux (2b) at the ICP IM sites. The larger value of bulk deposition (DC) and throughfall deposition (TF) has been used for estimating N deposition.*

Table 4.1 Number of statistically significant ($P < 0.05$) decreasing (-) and increasing (+) trends at the ICP IM sites for bulk deposition fluxes (DC flux), bulk deposition concentrations (DC conc.), runoff water/soil water fluxes (RW/SW flux), and runoff water/soil water concentrations (RW/SW conc.). The star (*) indicates non-marine (seasalt corrected) concentration. For NH_4, RW/SW trends have not been calculated.

	DC flux	DC flux	DC conc.	DC conc.	RW/SW flux	RW/SW flux	RW/SW conc.	RW/SW conc.
Trend direction	-	+	-	+	-	+	-	+
Variable								
SO_4*	4		9		4	1	5	
(Ca + Mg)*	6	1	5	1	5		3	1
H^+	5		7		3		3	1
NO_3	3		9		4		5	2
NH_4	7		7					

4.4 Conclusions

The results partly confirm the effective implementation of emission reduction policy in Europe. However, clear responses were not observed at all sites, showing that recovery at many sensitive sites can be slow and that the response at individual sites may vary greatly. Continued national and international research and monitoring efforts are needed to obtain scientific evidence on the recovery process to support future emission reduction policies.

4.5 Future work

The aim is to continue systematic scientific work in this field. The following activities are currently planned:

- Scientific paper to evaluate the C/N ratio in the soil organic horizon as an indicator of nitrate leaching. ICP IM data is used as part of the IFEF database (Indicators of Forest Ecosystem Functioning), comprising of nitrogen deposition and nitrate leaching fluxes, soil and ecosystem characteristics, in 251 forests from countries across Europe. Paper ready 2002.

- Scientific paper on proton budgets (including assessment of the relative effects of nitrogen processes). Ready 2003.

- Scientific paper on trends. Ready 2004.

- Scientific work and publications in projects with a global change perspective. It is planned to use data from sites in the ICP IM network in the EU-project 'Carbon and nitrogen interactions in forest ecosystems (CNTER, 2001-2004)', and in the project 'Climate induced variation of dissolved organic carbon in Nordic surface waters (NMDTOC, 2001-2002)' of the Nordic Council of Ministers.

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5 Progress report on dynamic modelling of surface water and soil

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5.1 Introduction

Long time-series data of water chemistry coupled with reliable data describing catchment physico-chemical characteristics and atmospheric deposition flux is essential for testing dynamic models. Twelve years of surface water data exist for the UK ICP IM sites and the MAGIC model has been re-calibrated and driven with observed annual deposition fluxes. The re-calibrated models have been used to predict the future response to the emission reductions agreed under the Gothenburg Protocol. As a result of uncertainties in our current understanding of nitrogen dynamics, an assessment of 'best' and 'worst' cases with respect to future N leaching is described by the model. Changes in future N leaching may result from the onset of N-saturation in catchment soils as a result of continued N deposition or may be the result of a change in, for example, hydrometeorological conditions. The ICP IM sites offer a unique opportunity to assess the causes of long-term changes in N leaching.

In addition, there is a new focus on 'dynamic modelling' within the Convention with a view to review of the Gothenburg Protocol. Dynamic models need to be assessed with regard to their ability to provide relevant information to Integrated Assessment Models. In this respect, the dynamic models can be used to construct 'critical load functions' for sites which are dependent on the time specified to achieve some chemical limit.

5.2 Model testing

At the UK ICP IM sites (Allt a Mharcaidh, GB0l and Afon Hafren, GB02) the MAGIC model has been tested against the observed 12 year record of water chemistry. The model was re-calibrated to the mean 1988-1993 chemistry as during this period no trends in any ion were evident although there is considerable variation in the mean annual chemistry over the period. The reconstructions of pH and ANC (Figure 5.1) show little acidification at Allt a Mharcaidh but a marked increase in acidity at Afon Hafren since the 1950s. At Afon Hafren, the chemical response is impacted by afforestation which also began in the late 1950s. Through the period 1988 to 1999, the model simulation compares generally well with the observed mean chemistry and predictions are within the range of the observed data.

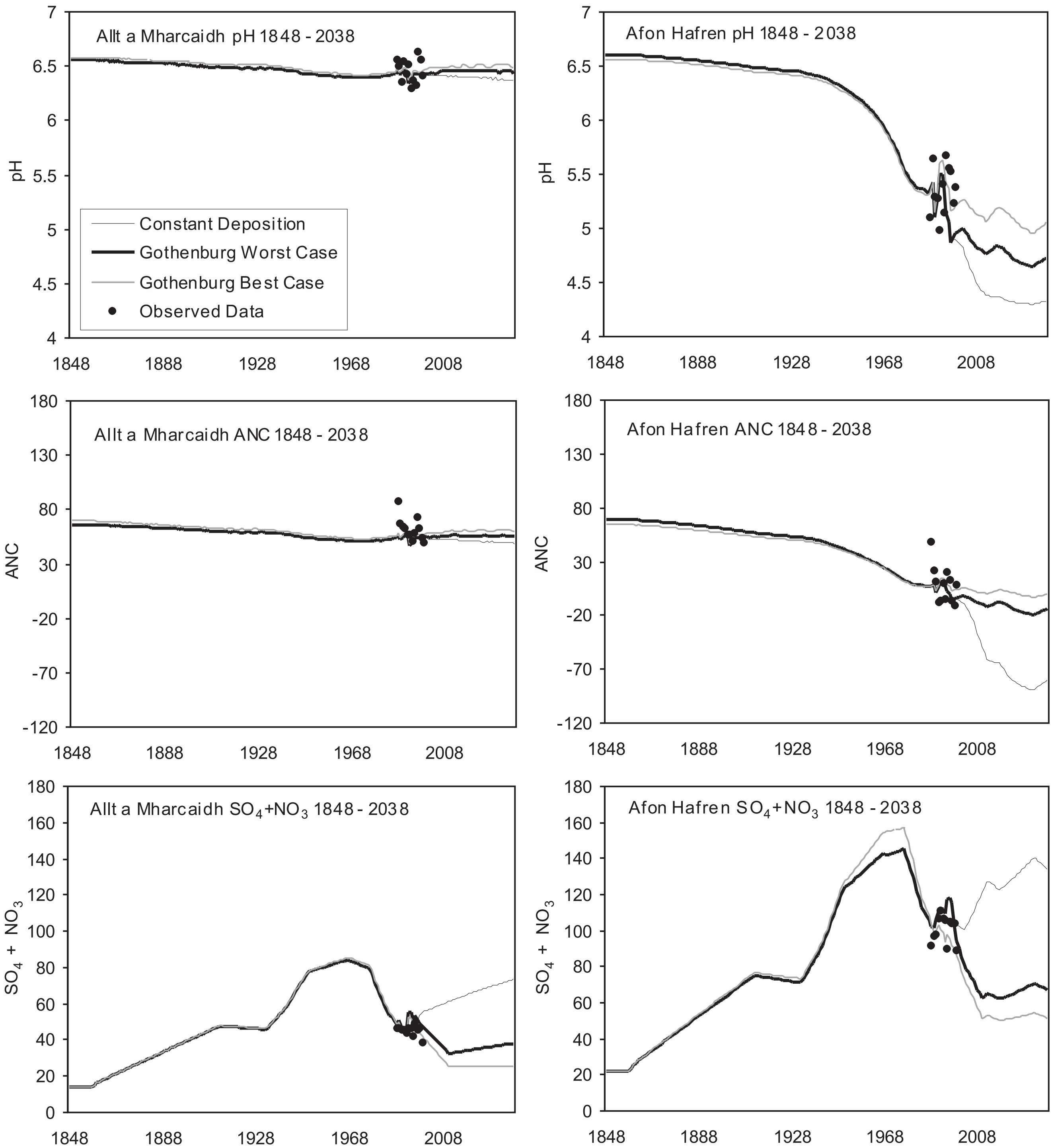

Figure 5.1 Simulated streamwater pH, ANC (µeq/l) and SO4 + NO3 (µeq/l) calculated with the MAGIC model at ICP IM sites Allt a Mharcaidh (GB0l) and Afon Hafren (GB02) with constant deposition and reductions agreed under Gothenburg Protocol.

5.3 Future predictions

The model has been run forward to assess the changes in surface water chemistry under the emission reductions agreed for the Gothenburg Protocol. The impact of the agreed reductions are assessed against a scenario of constant future deposition at current levels. At the Allt a Mharcaidh, little change is predicted but at the Afon Hafren the reduced deposition is predicted to be sufficient to at least prevent further acidification. In addition, the model has been run assuming two scenarios for future nitrate leaching; a best case which assumes that nitrogen saturation will not occur and a worst case which assumes that the soils are currently nitrogen saturated leading to increased nitrate leaching into the future despite decreased N deposition.

The 'best' and 'worst' cases for N leaching have a less significant impact on predicted ANC than the agreed S reductions. This is because NO_3 concentrations is currently relatively low and even at a worst case assumption for decreased N immobilisation, the decrease in N is sufficient to keep the NO_3 leaching at roughly its current level. This emphasises the importance of actually achieving the agreed S and N emission reductions to promote chemical recovery from acidification over the next 20 years. The fact that both 'best' and 'worst' cases for N leaching provide rather similar ANC simulation to 2010 further indicates that it is the sharp decline in S deposition under the Gothenburg Protocol that is mainly driving the model response. This further emphasises the need to achieve the S emission reductions as agreed. Uncertainty over the future retention of N remains, however, and beyond 2020 decreasing catchment retention could lead to NO_3 becoming the dominant anion and potentially leading to further acidification in the longer term.

5.4 Future work

The dynamic modelling work led by A. Jenkins, United Kingdom, is carried out in cooperation with other ICPs and coordinated by the UN/ECE Expert Group on Dynamic Modelling. The ICP IM Task Force 2001 agreed on the following time schedule for the future work:

- Model calibrations and recalibration of existing versions (MAGIC model); inclusion of new sites.Active participation from NFPs is required in the calibration of new sites. Progress will be reported at the next Task Force meeting in 2002.

- The possibilities to arrange a modelling workshop to provide training for NFPs (possibly organized back-to-back with the Task Force meeting in 2002) will be explored.

- Technical report , a draft will be presented at the Task Force meeting in 2002.

Reports on national ICP IM activities

6

6.1 Report on national ICP IM activities in Estonia

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The main objective of the international activities carried out pursuant to the UN/ECE Convention on long-range transboundary air pollution is to monitor the impact of air pollution on the ecosystems of Estonia (Environment Action Plan, 2001). The initiative of the Nordic Council of Ministers on funding technical installations in the field, as well as in laboratories, and to start Integrated Monitoring in Estonia, was greatly welcomed. Estonia started with the ICP IM programme in April 1994. Since then, ICP IM belongs to the Estonian national monitoring system and is funded from the state budget.

The long-term monitoring of biological, chemical and physical state of natural ecosystems and catchments within the programme will result in a valuable database on biological and chemical effects which may result from changes in atmospheric deposition in the country, and in evaluations of resulting effects within the whole European network.

Legislative basis for the monitoring activities are e.g. Environmental Monitoring Act (20 January 2000), Decree on five permanent monitoring sites; Database Act (12 March 2001), Register Act (draft).

Estonia participates in four UN/ECE ICP programmes under the Convention on Long-Range Transboundary Air Pollution, CORINE programs on land cover, water, air and nature. Integrated monitoring is carried out at Vilsandi and Saarejärve monitoring sites.

Vilsandi monitoring site

At Vilsandi the following 13 subprogrammes are carried out: AM, AC, PC, MC, TF, SF, SC, SW, FC, LF, VG, EP, MB. Precipitation of Vilsandi is slightly acid (pH 4.58), higher pH was measured in August. Deposition of sulphate was 2.3 kg/ha, which is lower compared to earlier years, nitrate 1.7 kg/ha, chloride 5.6 kg/ha and Na 2.9 kg/ha. Deposition of Zn and Cu is higher than of other heavy metals which is caused by fly ash from power plants working on oil-shale.

Compared to open field precipitation, some ions showed higher concentration in throughfall, where dry and wet deposition with leached products from foliage together form the amount of deposition (70% of open field precipitation). pH was higher from June to November. More acid dry deposition was determined in winter.

SO_4-S deposition in throughfall was three times higher than in precipitation (7.2 kg/ha). Nitrate, Ca, Mg, Na and Cl ions were positively correlated with sulphate (r> 0.65). Stemflow was more acid (pH 4.26) and nutrient concentration (NO_3, NH_4 and P) was lower than in precipitation and throughfall, but much higher for other elements.The data are very important for characterising the living conditions of trunk epiphytes.

Soil water was characterised by higher mean concentration of Fe (0.72 – 1.1 mg/l) and litterfall by deficiency of P and K. Compared to 1994, Ntot in soil has decreased in all horizons, all heavy metals were concentrated in higher humus layers. Analysis of heavy metals showed higher content of Cu, Ni, and Fe. When comparing present heavy metal content in mosses to the content in 1990, Cd, Cr, and Fe are decreasing in both *Pleurozium schreberi* and *Hylocomium splendens.* Concentrations of Cu and Pb are increasing, and Ni is increasing in *Pleurozium schreberi* but decreasing in *Hylocomium splendens;* Zn is decreasing in *Pleurozium schreberi.*

In general, the deposition of pollutants at Vilsandi is low and Vilsandi is suitable for a background station. Nutrients and pollutants which are depositing through air and leached out through soil water show in time balanced ecosystem.

Saarejärve monitoring site

Saarejärve is an intensive site where 29 subprogrammes were carried out. In 2000, geobotanical analysis of plant cover and analysis of soil were also carried out. Year 2000 was not very rich in precipitation but element content and deposition were higher. Compared to other ICP IM stations, Ca content was quite high and deposition of it was one of the highest (11.3 kg/ha). SO_4-S is decreasing compared to years from 1995 (4.52 kg/ha). Higher concentrations are in correlation with heating season and seasonal activities of the power plants. Ntot deposition was 3.9 kg/ha which was quite low and showed no growing influence of agriculture. Throughfall chemistry in spruce and pine stands shows three times lower SO_4-S concentrations compared to year 1995 in spruce stand and two times lower SO_4-S concentrations in pine stand. Ca and Mg as fly ash components from power plants show decreasing concentration. Acidity of soils and the level of mobile Al was higher in spruce stand, P content was higher in deep horizons which was of great importance for the nourishment of roots. Soil water (pH 4.2) was characterised by higher concentration of Al, Fe and Mn and very low concentration of N and P.

Nutrient (N, P, K) discharge from the catchment area is low and there is no danger of eutrophication for the lake ecosystem. Discharge of SO_4-S was 300 g/ha higher than recharge. It shows lower pollution by SO_4-S from air during recent years. Ground water analysis characterise glaciofluvial sand which has high concentrations of Ca, Mg and carbonates.

Defoliation per cent of spruce stand was 14.8% and pine stand 14.0%. Vitality of trunk epiphytes is more determined by growing conditions than by deposition of pollutants. During the most important process in the circle of elements of the ecosystem, decomposition of litter, the concentration of K and B decreased by leaching remarkably. Other elements show increasing concentration, especially Ca 500%. The elements are immobilised into microbial biomass.

It could be concluded by results of analysis that air pollution and deposition of pollutants has been decreasing, discharge of sulphate is higher than the pollution load of the catchment area: processes of self-purification are remarkable. State of pine and spruce stands has improved. Sulphate concentrations are decreasing in precipitation and throughfall and pollutants concentration in soil water from deeper horizon is decreasing.

Acknowledgements

Hereby we would like to thank all who has made this work possible: Prof. T. Frey, Dr. J. Frey, Dr. E. Nilson, K. Pajuste, A. Kullapere and M. Aumees.

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6.2 Report on national ICP IM activities in Ireland

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There is one ICP IM site located in Ireland. This monitoring site is called Brackloon Wood (IE01), and is located in the western part of Ireland, close to the coast.

Brackloon Wood is approximately 74 hectares of semi-natural woodland. Approximately 15 hectares comprises predominantly *Quercus petraea*, with an understory of *Sorbus aucuparia, Betula pubescens* and *Ilex aquifolia*. Records show that most of the *Quercus* in the wood dates from 1830. The remaining parts of the wood are a broadleaf/conifer plantation. However, most of the conifers have recently been removed, as part of a Woodland Improvement scheme.

Monitoring activities commenced at this site in 1991, under EU Regulation 3528/86 on the Protection of the Communities Forests against Atmospheric Pollution. Under this monitoring programme, intensive monitoring of deposition (precipitation, throughfall and stemflow), soil solution (at 3 depths), litterfall, ammonia concentrations and meteorology has been carried out. In addition, forest health, increment, soil and foliage chemistry have also been monitored.

Laboratory analysis of water and solid samples is carried out at our own laboratory in University College Dublin. We have participated in a number of international intercalibration programmes of both water and solids, and continue to do so, to maintain the quality of our data.

In 1997, Brackloon Wood was included into the ICP IM network, and at this time, funding was gained which allowed for an expansion of the monitoring activities, to include monitoring of vegetation, birds and mammals, in addition to other parameters (soil type distribution, radionuclides, pollen etc).

Data was submitted for the first time, in 1999 comprising deposition, soil solution, foliage and litterfall.

Priorities for 2001

We will continue to monitor deposition, soil solution, foliage, litterfall, forest health, increment and ammonia concentrations, under existing funding.

We are awaiting the publication of the final report on the additional monitoring which was carried out in 1997 and 1998. When this report is available, additional data will be submitted to the ICP IM programme centre. In addition, we will then also commence planning for repeat surveys of certain aspects of the monitoring (especially vegetation).

6.3 Report on national ICP IM activities in Italy 2000-2001

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All sites belonging (since 1997) to the National ICP Integrated Monitoring network are a part of the National Integrated Network for Forest Ecosystem Monitoring (CONECOFOR), established in 1996 in the framework of European Union Regulation no. 1091/94 and the ICP Forests. This network includes 27 intensive sites 100.000-1.000.000 m^2 large (including the analysis area, 5.000 m^2 large), selected on the basis of high levels of ecological uniformity (in relation to soil, vegetation and local climate). Each site includes only a type of habitat and plant community, typical for the region.

Ten of the sites are classified ICP IM sites; sites are distributed overall the national surface and are representative of the most important forestry biocenoses (beech woods, 3 plots; spruce woods, 3 plots; turkey oak woods, 2 plots; holm oak woods, 1 plot; European oak woods, 1 plot).

Analyses performed include crown condition assessment, chemical content of soil and of leaves, deposition, tree growth assessment, meteorology and ground vegetation assessment.

Field-work is carried out, on each plot, by several teams of people from decentralised structures of the National Forest Service, from Regional Administrations or by researchers of local laboratories. Intercalibration courses and updating meetings are annually organised to make field work easier and to improve data quality.

The National Focal Point is represented by the General Direction for Forestry, Mountain and Water Resources (5th Unit) of the Ministry for Agriculture and Forestry Policy. The NFP makes annually contracts with National Research Institutes responsible for the scientific co-ordination of the analysis, data collection and evaluation. A tutor, who has the responsibility for plot management and for field works has been appointed for each permanent plot (tutors are people from National Forest Service or from Regional Administrations in the case that plots were located in areas of Regional property).

Most of plots are located on hill or mountain slopes at altitudes between 500 and 1500 m and are distributed over two bioclimatic regions from the Euro-Siberian to the Mediterranean.

In the framework of the CONECOFOR Programme, the data included in the Table 6.1 are available.

The first five years of the CONECOFOR Programme implementation allowed to in depth describe several forests biocenoses in Italy. They have been studied in all the most important components such as soil, ground vegetation, macro- and micro-climate, atmospheric pollutants. Information has been collected on the health of wood populations and their structure and functioning. In the future this kind of 2nd Level analysis should be supported by experiments of 3rd Level, which operate ecosystems manipulation and are already active in several European countries and in the USA.

Table 6.1 Data available from the CONECOFOR Programme.

Subprogramme	No of sites	Frequency	Data from years
BV: Inventory of plants	10 sites	1 year	1996/7, 1999-2001
AM: Climate	07 sites	1 sec	1997-2001
AC: Air chemistry	09 sites	1 week	1996-2001
PC: Precipitation chemistry	07 sites	1 week	1997-2001
TF: Throughfall	07 sites	1 week	1997-2001
SF: Stemflow	06 sites	1 week	1997-2001
SC: Soil chemistry	10 sites	10 years	1995/6
RW: Runoff water chemistry	02 sites	1 week	1997-2001
FC: Foliage chemistry	10 sites	2 years	1995, 1997, 1999, 2001
FD: Forest damage	10 sites	1 year	1996-2001
VG: Vegetation	10 sites	1 year	1996/7, 1999-2001
PA: Plant cover inventory	10 sites	1 year	1996/7, 1999-2001

The data collected in the first four years of the activity were subjected to a first evaluation which can be considered as a first attempt at providing a concrete example of the Integrated and Combined evaluation system. In this context, the potential for co-occurrence of sensitive soil conditions and high deposition of acidifying compounds and nitrogen was examined. Similarly, ozone levels and indices of drought stress were considered. Tree condition, ground vegetation and ozone data collected at beech sites were jointly examined to show how the status and change analysis could work. Results show that there is the potential for exceedance of critical acidity loads in the most sensitive forest ecosystems in Italy. Ozone values were rather high as mean weekly values, however, there is evidence that the uptake of ozone may be affected by different meteorological conditions in different years. The status and changes of five beech sites were found to fluctuate around a mean, with two sites being far from the mean distance in 1999.

This kind of long-term research and monitoring are very important in the National contest, since the assessment and monitoring of forest health represent a key point for environmental policy and for the management of environmental resources in the frame of sustainable development.

Contact information

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National research institutes responsible for the scientific co-ordination of the analysis, data collection and evaluation:

- **Soil and leaves:** DISAFRI - Università di Viterbo *(*Prof. G. Sacarascia-Mugnozza*)*, e-mail: gscaras@unitus.it
- **Climate:** Istituto Sperimentale per la Nutrizione delle Piante, Roma *(*Dr. A. Costantini*)*, e-mail: conecofor@isnp.it
- **Vegetation:** Dipartimento di Botanica ed Ecologia - Università di Camerino (Prof. R. Canullo), e-mail: botanica@camserv.unicam.it
- **Crown condition:** Dipartimento di Biologia Vegetale - Università di Firenze (Dr. F. Bussotti), e-mail: fbussotti@cesit1.unifi.it
- **Deposition:** Istituto Italiano di Idrobiologia - Consiglio Nazionale Ricerche, Pallanza (Dr. R. Mosello), e-mail: r.mosello@iii.to.cnr.it
- **Ozone:** Istituto Ambiente Italia, Milano (Dr. A. Buffoni), e-mail: ab-studio@libero.it

Additional report on activities in Trentino-South Tyrol 2000

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The survey at the permanent observation plots of IT01 Renon/Ritten, IT02 Monticolo/ Montiggl, IT03 Lavazè, and IT04 Pomarolo were carried out also during 2000 according to international research programmes (ICP IM, CARBOEUROFLUX and FORCAST). Following subprogrammes were implemented: Meteorology, Air Chemistry, Deposition (Precipitation Chemistry, Stemflow, Throughfall), Litterfall Chemistry, Soil Water Chemistry, Forest Damage, Carbon and Water Vapour fluxes as well as Energy flux and Balance by eddy correlation (IT01).

A special effort was put in a careful investigation concerning Foliage Chemistry, Soil Chemistry, Soil microbiology and physiology, Ectomycorrhiza and fine-root systems as well as Biomonitoring through sampling of diverse faunal groups, which were already performed during 1993 and 1995.

Just the faunal investigations allowed to discover new findings in South Tyrol e.g. at IT01 the Forest Dormouse, *Dryomys nitedula* (rodent-Muscardinidae) a bioindicator for well-balanced conditions in forest stands, 11 species of springtails among which *Karlstejnia norvegica Fjellberg 1994* was a new record genus for Italy.

Among the butterflies, 18 new species were reported for the first time in Trentino, 3 in South Tyrol and 2 *Stigmella hahniella* (Wörz 1937), *Trifurcula moravica* Lastuvka & Lastuvka 1994) in Italy.

All these species are going to add to the near 3000 species of plants, animals, insects, fungi and other organisms, which were classified in the four permanent plots since the ICP IM programme started, so that the high grade of biodiversity on the studied sites indicates satisfactory ecological conditions.

A report about the results of the 2000 campaign will be published during 2001.

Published reports and articles based on integrated monitoring data

Huemer, P. 2001. Biomonitoring der Schmetterlingsfauna (Lepidoptera) an den Dauerbeobachtungs-flächen IT01 Ritten und IT02 Montiggl. Report 2000. Ed. Forest Department - Autonomous Province of Bolzano.

Kopeszki, H. 2001. Passive und aktive Bioindikation mit Sprigschwänzen (Collembola) an den Waldstandorten IT01 Ritten und IT02 Montiggl. Report 2000. Ed. Forest Department - Autonomous Province of Bolzano.

6.4 Report of national ICP IM activities in Latvia 2000-2001

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Introduction

The programme observations have gone on throughout the years 2000-2001 at two ICP IM stations, Rucava and Zoseni, established under the UN ECE Convention on Long-range Transboundary Air Pollution aimed at studying transboundary air pollution impact on ecosystems. These same stations are part of the international observational networks, GAW (regional), EMEP, EUROAIRNET and EUROWATERNET and are among the Terrestrial Ecosystem Monitoring sites providing metadata for GTOS.

The measurement results have been extensively used in decision making on environmental protection issues. Transboundary air pollutants transfer and implications to the environment were covered in the national Environmental Policy Plan for Latvia. In a large measure, this is fostered by the key factors responsible for background quality of the environment of Latvia, namely:

- *The physico-geographical position: the territory of Latvia is under impact of western, south-western transfer of air masses that bring air pollutants from European countries.*

A stabilisation has been observed in deposition of oxidised sulphur and reduced nitrogen onto the territory of Latvia since 1993. Oxidised nitrogen deposition has shown the tendency to increase (by 30% compared to 1998) (Figure 6.1).

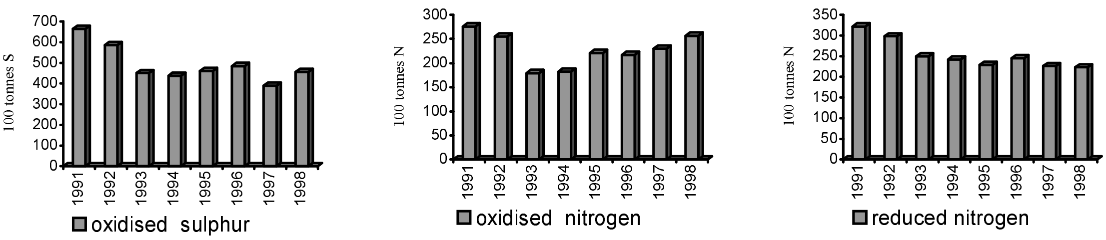

Figure 6.1 Annual deposition of oxidised sulphur, oxidised nitrogen and reduced nitrogen in Latvia.

The Latvian contribution to pollution of its environment is 11% for oxidised sulphur, 5% for oxidised nitrogen and 34% for reduced nitrogen.

- *Local air pollution sources, their location and amounts of emissions.*

A stabilisation of the downward tendency was observed in 1998, compared to 1990, in total emissions of pollutants, with 50% decrease in sulphur dioxide, 66% of nitrogen oxides, 76% of carbon oxide and 35% of solid substances (Figures 6.2-6.3).

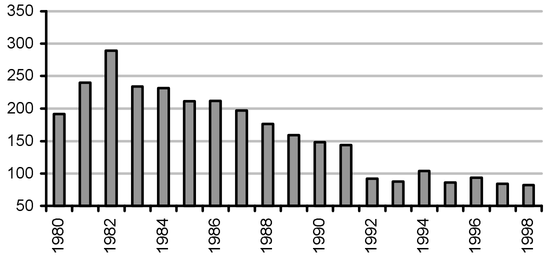

Figure 6.2 Year-to-year dynamics of total emissions (1000 tonnes per year) from stationary sources.

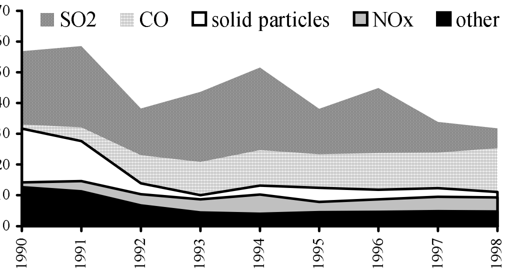

Figure 6.3 Year-to-year dynamics of pollutants (1000 tonnes per year) from stationary sources.

• *The climatic conditions of areas under observation: the precipitation, air temperature and soil temperature, total radiation, duration of growth period, level and flow of surface waters (Figures 6.4-6.7).*

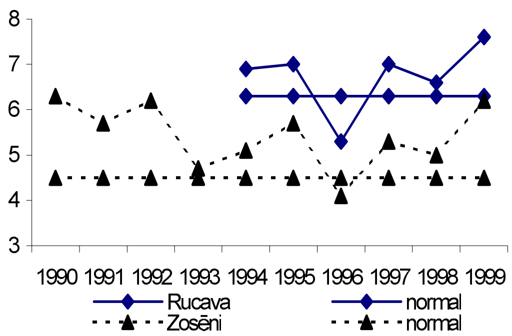

Figure 6.4 The mean annual air temperature (⁰C).

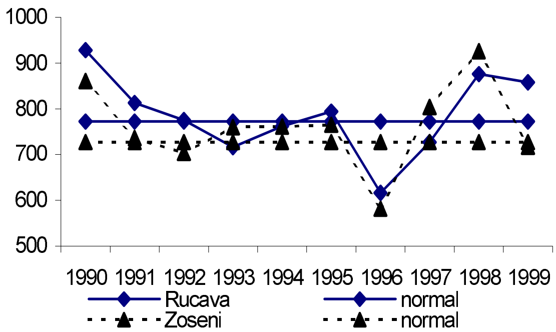

Figure 6.5 The annual precipitation (mm).

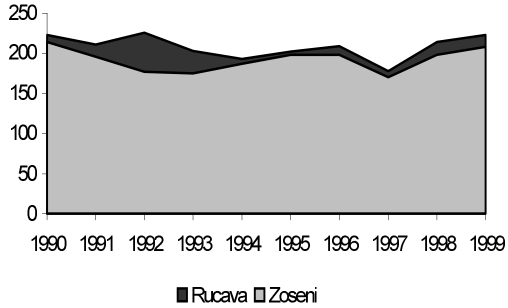

Figure 6.6 The duration (days) of the growth period.

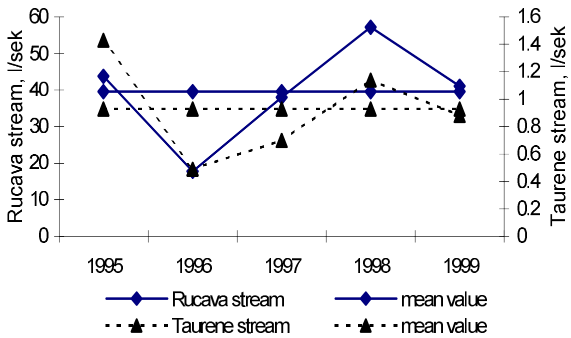

Figure 6.7 The mean annual water flow (l/sec).

Summary of results from background stations

Sampling and analysing of the ambient air, precipitation, surface water, soil water and groundwater at the stations of Rucava and Zoseni were performed by the Environmental Quality Observation Department, Latvian Hydrometeorological Agency (LHMA). The observation of vegetation, forest damage, trunk epiphytes, foliage chemistry, litterfall and soil chemistry were provided by researchers from the Latvian University (LU).

The samples were analysed by the LHMA's laboratory, which has passed accreditation according to the EN ISO/IEC 17025 standard. In order to ensure analysis quality and control, the LHMA's laboratory participated in intercomparison exercises held by NILU (air, precipitation), NIVU, QUASIMEME, ITM-Stockholm University (surface water), WMO-Acid Rain (precipitation) and Landesumweltamt Nordrhein-Westfallen Germany (needles). Though the intercomparison results were fairly good, the determinations of some parameters have to be enhanced.

The measurement results were covered in detail at the ICP Waters Task Force meeting held in Riga, Latvia, 2000. The observation data were involved in plotting the ecological maps for Latvian forestry and presented to local and international conferences and workshops: XXI Nordic Hydrological Conference (Uppsala), EUROTRAC-2 Symposium (Garmisch-Partenkirchen), Workshop on analysis of ozone trends (Cologne), ICP IM Task Force Meeting (Vilnius), Task Force on Modelling and Measurement (Vienna), EUROWATERNET workshop (Silkeborg)), 59th Latvian University Scientific Conference (Riga), Workshop on Future Environmental Monitoring and Data Cooperation between the Nordic Council of Ministers and the Baltic and the Northwest Russia (Tallinn).

General measurement results under GAW/EMEP and ICP Waters (1990-1999) and ICP IM (1994-1999) are presented in Table 6.2.

Defoliation of the crown of a tree is an integrated indicator of the crown, and the tree's, health. Assessments of defoliation in pine trees showed the upward tendency in 1994-1999 by 2 % at Zoseni and 3 % at Rucava on average (Figure 6.8).

Ozone concentration exceedances of a vegetation protection threshold of 65 μg/m^3 were recorded throughout the years of the observations with the higher number of the exceedances in the vegetation period (Figure 6.9).

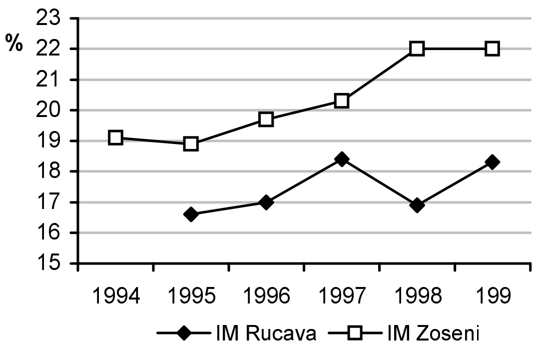

Figure 6.8 Dynamics of defoliation in pine trees (%), IM stations Rucava and Zoseni, 1994-1999.

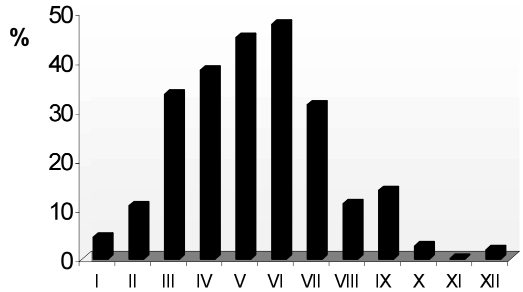

Figure 6.9 Ozone concentration exceedences of a vegetation protection threshold of 65 μg/m^3, station Rucava,1994-1999.

Table 6.2 General measurement results under GAW/EMEP and ICP Waters (1990-1999) and ICP IM (1994-1999). (Trend assessment of soil water not carried out due to a short observation period).

Programme	**pH**	**$N\text{-}NH_4$+ $N\text{-}NO_3$**	**N_{tot}**	**P_{tot}**	**$P\text{-}PO_4$**	**$S\text{-}SO_4$**	**S_{tot}**	**Ca+ Mg+K**	**Pb**	**Cd**	**Cu**	**Zn**
Regional GAW/EMEP	***Total deposition***											
♦ Rucava station			☺				☺					
♦ Zoseni station			☺				☺					
Regional GAW/EMEP	***Wet deposition***											
♦ Rucava station	☹	♦				☺		☺	☺	♦	♦	♦
♦ Zoseni station	☹	☺				☺		♦	☺	♦	☺	♦
ICP-IM	***Open area deposition***											
♦ Rucava station		☹			♦	♦		☹	♦	♦	☹	♦
♦ Zoseni station		☺			☹	☺		☺	☺	♦	♦	☺
ICP-IM	***Throughfall deposition***											
♦ Rucava station		♦			☹	♦		♦	♦	♦	☹	♦
♦ Zoseni station		☺			♦	☺		♦	☺	♦	♦	☺
ICP-IM	***Precipitation chemistry***											
♦ Rucava IM station	☺	♦			☹	☺		☹	♦	♦	♦	♦
♦ Zoseni IM station	♦	♦			☹	☺		♦	☺	♦	♦	☺
	Throughfall											
♦ Rucava IM station	☺	☺			☹	☺		♦	♦	♦	♦	☺
♦ Zoseni IM station	♦	♦			♦	☺		♦	☺	♦	♦	☺
	Stemflow											
♦ Rucava IM station	☺	♦			☺	☺		♦	♦	♦	♦	♦
♦ Zoseni IM station	♦	♦			☺	☺		♦	☺	☺	♦	☺
ICP-IM	***Foliage chemistry***											
♦ Rucava station			♦	☹				♦	☺	♦	♦	♦
♦ Zoseni station			♦	♦				♦	☺	☹	♦	♦
ICP-IM	***Litterfall chemistry***											
♦ Rucava station			♦	♦				☺	♦	♦	☺	♦
♦ Zoseni station			♦	♦				☺	♦	♦	♦	♦
ICP-IM	***Metal chemistry of mosses***											
♦ Rucava station									☺	☺	♦	☺
♦ Zoseni station									☺	☺	☹	☺
ICP-IM	***Soil chemistry***											
♦ Rucava station	☺		♦	☺				☺	☺	☺	☺	☺
♦ Zoseni station	☹		☹	☺				☹	☺	☺	☺	☹
ICP-IM	***Soil water chemistry***											
♦ Rucava station	♦	☹		☹		♦		♦				
♦ Zoseni station	☺	☹		☹		☹		☹				
ICP-IM	***Groundwater chemistry***											
♦ Rucava station	♦	♦		☹		☺		♦	☺	☺	☺	☺
♦ Zoseni station	♦	♦		☹		☺		☺	♦	☺	☺	☺
ICP-Waters	***Runoff water chemistry***											
Tulija river	♦	♦	☺	☺		♦		♦	♦	♦	♦	♦
Liela Jugla river	♦	☺	♦	♦		♦		♦	♦	☹	♦	♦
Barta river	♦	☺	☺	♦		♦		☺	♦	♦	♦	☹
Burtnieku lake	♦	♦	☺	♦		♦		♦	♦	☺	♦	♦
Zvirbuli stream	♦	♦		☺		☺		♦				
ICP-IM	***Runoff water chemistry***											
Zoseni forest stream	♦	♦	♦	♦		☺		♦	♦	♦	☺	♦
Rucava forest stream	☺	☹	☺	☹		☺		♦	☺	♦	☺	☺

Tendencies:☺-decrease,☹-increase(for pH:☺-increase,☹-decrease), ♦-stabilisation

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Future work

- Cooperative works with the ICP Forests (including the II level measurements at ICP IM stations) and the ICP Waters.
- Implementation of the ICP IM subprogramme VS: Vegetation structure and species cover.
- Participation in laboratory intercomparisons on soil (QUASIMMEME), precipitation (WMO-Acid Rain, NILU), surface water (NIVA), needles (Landesumweltamt Nordrhein-Westfallen Germany), air (NILU).
- Participation in the preparation of a Joint Assessment Report for 2002 to be prepared by the EMEP centres and the national EMEP experts.
- Provision of material to the EMEP centre's Joint Report 'Atmospheric Supply of Nitrogen, Lead, Cadmium, Mercury and Lindane to the Baltic Sea in 1998'.
- 2001 ICP IM data reporting to the IM database.

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Responsibility for the implementation of subprogrammes:

- Latvian Hydrometeorological Agency - Climate, Air chemistry, Precipitation chemistry, Throughfall, Runoff water chemistry, Groundwater chemistry, Hydrobiology of streams.
- Latvian University (Dr. O. Nicodemus) - Soil, Soil water, Litterfall chemistry, Foliage chemistry, Metal chemistry of mosses, Stemflow.
- Latvian University (Dr. M. Laivinsh) - Vegetation, Forest damage, Trunk epiphytes, Forest stand inventory, Vegetation structure and species cover.

6.5 Report on ICP IM activities in Lithuania

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During 1993-1999, the Integrated monitoring Programme was carried out in the three Lithuanian ICP IM areas: Aukstaitija (LT01), Dzukija (LT02) and Zemaitija (LT03) (since 1994).

The Aukstaitija integrated monitoring site is situated in the northern part of Aukstaiciai upland – Azvinciai nature reserve of ANP in the catchment of Versminis small river. The geographical coordinates: longitude 26°03′20″ - 26°04′50″ E, latitude 55°26′00″-55°26′53″ N. The catchment area is 1.015 km^2. The lowest elevation in the catchment is 159.5 m, the highest 188.6 m a.s.l.. The climate is categorised by warm winters with a thin snow cover and frequent thaws, rather cold springs, averagely warm summers and warm and rainy autumns. The long-term mean annual air temperature is 5.8°C, the mean annual precipitation is 682 mm. LT01 is predominated by podzolic forest weakly podzolized soils. Most of the catchment is covered with coniferous multi-layer stands. Stands are mostly composed of pines mixed with spruce.

The Dzukija integrated monitoring area is in the southern part of Dzukai upland – Skroblus nature reserve of DNP in the catchment Duburiai small river. The geographical coordinates are: longitude 24°15′55″ - 24°18′02″ E, latitude 53°03′40″-54°05′38″ N. The catchment area covers 3.8 km^2. The lowest elevation is 80.0 m, the highest one 134.5 m a.s.l..The climate is characterised by warm winters with a thin snow cover and frequent thaws, rather cold springs, averagely warm summers and warm and rainy autumn. The long-term mean annual air temperature is 6.0°C, the mean annual precipitation is 625 mm. The forest soils of LT02 have developed in the sandy plains of glacial genesis. The natural pine forests are predominated by poor in nutrients podzolic forest weakly podzolized sands. Pine forests dominate. There are a few stands of spruce and spruce with pines.

The Zemaitija integrated monitoring site is in the southern part of Zemaiciai upland – Plokstine nature reserve of ZNP in the catchment of Juodupis small river. The geographical coordinates are: longitude 21°51′56″ - 21°53′10″ E, latitude 56°00′19-56°01′05″ N. The catchment area is 1.473 km^2. The lowest elevation is 147.0 m, the highest one 180.1 m a.s.l.. The climate is characterised by warm winters with a thin snow cover and frequent thaws, rather cold springs, averagely warm summers and warm and rainy autumns. The long-term mean annual air temperature is 5.9°C. The long-term mean annual precipitation is 788 mm. The investigated catchment is predominated by podzolic forest sands covering more than half of the area (51.3%). Coniferous forests predominate, spruce forests with pine (up to 20-30%) are most common. Pure spruce forests cover also a large area of the catchment.

Unfortunately, because of reduced funding, observations in Dzukija IM area were suspended in the middle of 1999. Observations continued in the year 2000 only in Aukstaitija and Zemaitija IM areas.

The following subprogrammes are caried out in Lithuanian ICP IM sites: climate (AM), air chemistry (AC), precipitation chemistry (DC), throughfall (TF), soil chemistry (SC), soil water chemistry (SW), ground water chemistry (GW), runoff water chemistry (RW), litterfall chemistry (LF), hydrobiology of streams (RB), forest damage (FD), vegetation (VG), trunk epiphytes (EP), aerial green algae (AL) and forest stand inventory (AR).

In 1993-99 the biomass of stands in Aukstaitija IM site decreased from 263.9 t/ha to 245.4 t/ha, i.e. about 18.5 t/ha (7%). In 2000 the increment of stands amounts 47.6 t/ha (12.4% of biomass). The total biomass of stands amounted 24.9 thousand t., of which N 460.5 kg/ha, P 50.4 kg/ha, K 171.4 kg/ha, Ca 276.7 kg/ha. During the 6 years, the amount of these bioelements has increased from 4 to 7%.

In 1993-99 the biomass of stands in Zemaitija IM site decreased from 199.5 t/ha to 190.9 t/ha, i.e. 8.6 t/ha (4.3%). The increment of stands in 2000 amounts 19.9 t/ha (9.5% of biomass). The total biomass of stands amounted 28.1 thousand t., of which N 362.3 kg/ha, P 35.9 kg/ha, K 134.5 kg/ha, Ca 250.1 kg/ha. Amount of these bioelements has increased from 7 to 11% during the 6 years.

In 1993-96, forest conditions in Aukstaitija IM site became worse, average defoliation increased from 15.2% to 30.7%. This increase was caused by climatic factors (droughts of the summers) and pest outbreaks. In 1996-99, average defoliation reduced from 30.7% to 24.3%, however, by 2000 the forest conditions became worse again and defoliation reached 25%. Increase of defoliation might be caused by lack of precipitation in the year 2000.

The same situation was observed in Zemaitija IM site. Forest conditions in 1993-96 became worse, average defoliation increased from 18.6% to 25.8%. In 1996-99, average defoliation reduced to 20.2%, however by 2000 defoliation reached 23.4% again. Increase of defoliation might be caused by lack of precipitation in the year 2000.

Comparison of forest conditions in IM territories shows, that forest condition in Zemaitija IM territory is better than in Aukstaitija IM territory.

In 2000, the mean annual tropospheric ozone concentrations were 54.7 $\mu g/m^3$ (LT01) and 52.08 $\mu g/m^3$ (LT03). Ozone daily maximum concentration was recorded on the 3rd (104 $\mu g/m^3$) and on the 12th (101 $\mu g/m^3$) of June in Aukstaitija IM site and on the 4th of April (99 $\mu g/m^3$) and on the 8th of May (102 $\mu g/m^3$).

In 2000, the mean SO_4^{2-} weekly value in LT01 was 0.68 $\mu gS/m^3$ (varied between 0.22 and 1.72 $\mu gS/m^3$), in LT03 0.6 $\mu gS/m^3$ (varied between 0.23 and 1.63 $\mu gS/m^3$; SO_2 in LT01 0.49 $\mu gS/m^3$ (varied between 0.08 and 3.22 $\mu gS/m^3$), in LT03 0.47 $\mu gS/m^3$ (varied between 0.08 and 2.61 $\mu gS/m^3$); NO_2 in LT01 0.62 $\mu gN/m^3$ (varied between 0.20 and 1.84 $\mu gN/m^3$), in LT03 0.71 $\mu gN/m^3$ (varied between 0.08 and 2.06 $\mu gN/m^3$).

The mean $HNO_3+NO_3^-$ weekly concentration in Aukstaitija IM site is 0.43 $\mu gN/m^3$ (varies between 0.13 and 1.52 $\mu gN/m^3$) and in Zemaitija IM site 0.42 $\mu gN/m^3$ (varies between 0.14 and 1.07 $\mu gN/m^3$; the $NH_4^++NH_3$ concentration in Aukstaitija IM site 1.09 $\mu gN/m^3$ (varies between 0.43 and 2.19 $\mu gN/m^3$), in Zemaitija IM site 1.15 $\mu gN/m^3$ (varies between 0.42 and 2.46 $\mu gN/m^3$).

The 12% decrease per year of SO_2 concentration has been observed during the last 7 years. Concentrations are decreasing differently: in Aukstaitija IM site –13 %, in Zemaitija IM site –7 % per year. The trend of NH_4^+ concentrations is similar to SO_4^{2-}. Estimations of nitrates concentrations shows that they are also decreasing and the trend is more significant in the western Lithuania: LT03 –7 %, LT01 –4.7 % per year.

The results of analysis shows, that in 2000, weekly pollutant concentrations in precipitation vary: SO_4^{2-} between 0.12 - 1.94 (LT01) and between 0.14-2.91 (LT03) mg/l; NO_3^- 0.02-2.32 (LT01) and 0.18-1.53 (LT03) mg/l; NH_4^+ 0.04-1.86 (LT01) and 0.09-1.76 (LT03) mg/l. A similar variation of concentrations is observed throughout all territories. Variation scale of Cl^-, Na^+, Ca^{2+} concentrations is relatively low.

Wet deposition flow was calculated from concentration and precipitation amount. Flow variation depends on pollutant's concentrations in air and in precipitation and on precipitation. Mean annual pollutant concentrations are: SO_4^{2-} 225 mg/m^2 (LT01) and 312 mg/m^2 (LT03); NO_3^- 185 mg/m^2 (LT01) and 288 (LT03); NH_4^+ 188 mg/m^2 (LT01) and 322 mg/m^2 (LT03). Results shows, that annual flows of SO_4^{2-}, NO_3^-, NH_4^+ and H^+ in Zemaitija IM site are higher than in other ICP IM areas. This can be linked with higher annual amount of precipitation: LT03 681 mm/year, and LT01 593 mm/year.

Groundwater table is decreasing (compared to climatic average), due to less precipitation in Aukstaitija and Zemaitija sites, 83% (99%) and 85% (92%) respectively. Stabilisation period (from 1998 to 1999), which was predetermined by abundant amount of precipitation (121% from climatic standard in Aukstaitija and 123% in Zemaitija), has finished.

A decrease was observed in the concentrations of NH_4N, K, Mg, Cl, Mn, Fe and Si ions in groundwater in Aukstaitija and Zemaitija IM site, independently from groundwater depth. Concentration of NO_3N, Ca, P_{total} and alkalinity are decreasing in groundwater (depth up to 6 m) in both ICP IM sites. Ca and Na concentrations for deep groundwater (depth more than 6 m) are also decreasing, however, the concentrations of SO_4, NO_3N, and P_{total} are increasing.

In 2000, a decreasing tendency of output of elements from catchments was observed. In 2000, output from Aukstaitija IM site amounts only to 37-67% of 1993-1999 average value. Output of elements from Zemaitija IM site amount to 71-97% of 1995-1999 average value; only output of S exceeds the average value of the observed period and amounts to 115%. Output from Aukstaitija IM site in 2000 was: S 382 kg/km^2/year, N (NH_4N + NO_3N) 9.5, Ca 3282, Na 116, K 24.3, Mg 885, Cl 174, P_{total} 0.7 and Si 156 kg/km^2/year. Output from Zemaitija IM site in 2000 was: S 543 kg/km^2/year, N (NH_4N + NO_3N) 24.8, Ca 2506, Na 339, K 54.1, Mg 604, Cl 608, P_{total} 3.56 and Si 336 kg/km^2/year.

The influence of the decrease of elements in precipitation can be seen in decreasing groundwater concentrations and decreasing output from catchments.

6.6 Report on national ICP IM relevant activities in Norway 1999

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Introduction

The monitoring of air pollutants and their effects on ecosystems in Norway constitutes a comprehensive activity, with monitoring programmes on air quality, surface water, soils, forests and fauna (aquatic and terrestrial). Several institutions are involved of which NILU, NIVA, NISK and the University of Bergen undertake most of the activities aimed to support the Convention on Long-Range Transboundary Air Pollution (CLRTAP) and its Working Group on Effects (WGE). Studies of atmospheric deposition, surface water chemistry, aquatic biology (invertebrates) and forest condition are performed at approximately 20 sites to support the ICP Waters and ICP Forest programmes respectively. From two of these sites (Birkenes and Kårvatn) data are also reported to support the ICP Integrated Monitoring. In general, all available data derived from these activities are used to evaluate cause-effect relationships, while specific evaluations based on ICP IM data alone have not been prioritised. In this note, a general description on the WGE-related activities at Norwegian sites is presented with indication of plans for future assessments.

Summary of results from the Norwegian monitoring programme on acid deposition (SFT, 2000)

Reduced sulphur emissions in Europe have reduced the Norwegian concentrations of sulphate in precipitation in the order of 50-70 per cent since 1980. The reduction in the emissions of SO_2 is reflected in a decrease in concentrations of SO_2 in air by 70-99% from 1980 to 1999. No significant changes have been observed in the concentrations of nitrogen compounds neither in precipitation nor in air.

Sulphate concentrations in surface waters have decreased by 30-50 per cent from 1980-1999. In general, 1999 showed the lowest sulphate content in lakes and rivers measured since the monitoring programme was initiated. As a consequence, the acidification situation in lakes and rivers has shown a clear improvement in the 1990s with increases in pH and ANC (acid neutralising capacity) and decrease in inorganic (toxic) aluminium. There is no systematic long-term change in nitrate, although 1997 and 1998 in general show low values. During the last few years an increase in TOC has been observed. Further, improved living conditions for aquatic fauna have been documented in all regions. The invertebrate monitoring demonstrates an improvement with respect to damages to macro-invertebrates and since 1990 a positive trend is found in most of the watersheds. Regional differences are, however, still prominent. Generally, watersheds in southernmost Norway are more damaged than those further north, a trend which is also confirmed by data on littoral and planktonic crustaceans. Test fishing with gill nets in south-eastern Norway indicates improvement in the populations of both brown trout most being in good condition.

Forest condition in Norwegian forests has for several years been declining, especially for Norway spruce (*Picea abies* (L.) Karst.), with reduced crown density and more discoloured trees. This trend may now be turning. Results in 1998 and 1999 showed a small improvement compared to the previous years. The Norwegian results are in accordance with a general tendency in northern Europe. There is no abnormal tree death in Norwegian forests. The forest ecosystems investigated, which are representative for much of the Norwegian forest, have a satisfactory health condition. Soils show a slight increase in base saturation in the last 5 years, but this increase is not accompanied by a corresponding increase in soil pH. The water-extractable sulphate has decreased in all plots re-sampled in 1994 and later. The two last years a tendency to increased soil pH is observed.

At one monitoring site in Southern Norway (Solhomfjell, Telemark county) changes in the ground vegetation in coniferous forests which may be due to pollution effects have been observed. Changes in ground vegetation in birch forest found in other monitoring areas are however unlikely to be caused by air pollution. Censuses of epiphytic lichens show a clear relationship between lichen cover and damage status and the documented deposition of pollutants in precipitation, both relative to geographic variation and changes over time.

Plans for year 2001

On the Norwegian ICP IM plots as well as the intensive forest monitoring plots, time-series analyses are now being applied to evaluate the soil water chemistry variation over various temporal scales (long term, seasonal and weekly, including handling of artificial effects from lysimeter installation). From these studies we believe that we can definitely determine if there are long term trends (and recovery) in soil water chemistry for acidity, acid neutralising capacity and nitrogen. Also, seasonal variation and identification of the drivers for weekly variation will elucidate cause-effect relationships in the soil water chemistry, which can be a key and first step to understanding effects of S- and N-deposition upon forest ecosystems.

Also, two types of forest growth studies are being done. The idea is that growth is a supplemental health indicator. Firstly, relative stand growth from monitoring plots, defined as measured growth relative to expected growth due to standard yield functions, is correlated to various stress factors. Secondly, dendrochronological data is used as a second step to evaluate the importance of acute stress factors, in particular meteorological events like drought. This demonstrates that we will now emphasize the climatic stress factors more.

As a part of a Nordic Ministers of Councils (NMR) project and a EU-project, RECOVER2010, data from Norwegian monitoring sites are used to eveluate long-term trends of recovery from acidification in lakes and calibrated catchments (ICP IM sites). In addition, a new NMR-project will focus on trends in total organic carbon (TOC). Also in this work data from ICP IM sites will be used.

References

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6.7 Report on national ICP IM activities in Sweden 1999

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Introduction

The Swedish group has compiled results from 1999. This is the first year from which results from all four Swedish sites can be reported. These four catchments are located in nature reserves protected from forestry activities. All sites have forest stands of 100 years or more and at least three of them have been forest land for several centuries. The stands are dominated by conifers, mainly spruce forest of bilberry type.

The four catchments are SE04 – Gårdsjön, SE14 – Aneboda, SE15 – Kindla and SE16 – Gammtratten located from south-west and south towards north of Sweden. SE16 was not fully equipped in 1999 but since autumn 2000 monitoring is comparable to the other three sites. A climatic gradient is obvious from the southernmost site SE14 to the northern one, SE16 (Table 6.3).

Table 6.3 Geographic location and long-term climate at the Swedish ICP IM sites.

	SE04	SE14	SE15	SE16
Latitude; Longitude	N 58° 03' E 12° 01'	N 57° 05' E 14° 32'	N 59° 45' E 14° 54'	N 63°51 E 18°06
Altitude, m	114-140	210-240	312-415	410-545
Area, ha	3.7	19.6	19.1	45
Mean annual temp., °C	+ 6.7	+ 5.8	+ 4.2	+ 1.2
Mean annual precipitation, mm	1000	750	900	750
Mean annual evapot., mm	480	470	450	370
Mean annual runoff, mm	520	280	450	380

Hydrology

Also this year, warm periods occurred at the beginning with snowmelt periods in January and less pronounced spring peak flows. Otherwise spring was ordinary and late summer to early autumn was dry. A rather warm autumn caused high flows instead of the regular snow accumulation in October and November at SE16. Discharge during 1999 agreed rather well with the long-term means, except for SE04 which had 60% higher discharge, while the other sites did not deviate with more than 12%.

The catchments are characterised by comparably thin soils on top of the bedrock with the hydraulic conductivity stratified with depth. Comparably high values occurred in the upper soil layers, dominating the annual water flow pathways. In September 1999 a precipitation event with a peak of 38 mm was subject to a special study. This revealed the correlation between soil water, groundwater and discharge. Higher soil moisture content and elevated groundwater levels created a discharge peak having strong episodic influence on e.g. acidity and organic compound outflows. The dominance of water flows in the upper soil layers is also indicated in the rather low silica content in the runoff, c. 3 mg/l. These fairly rapid pathways mean fast and direct influence from deposition on the surface waters. It also results in waters of low ionic strength.

Acidity

Acidity in the bulk deposition was fairly similar between the sites with a pH of c. 4.7. In the throughfall, pH was slightly higher, 0.1-0.2 units. In the upslope recharge areas, acidity dominated, while downslope discharge areas were less acid or even with alkalinity (SE14). Runoff water from SE04 and SE14 showed a positive ANC, which could partly depend on rather high organic content (DOC 14-20 mg/l), while surface water at SE15 was constantly acid with a negative ANC. In the northern SE16 catchment, the highest pH (5.6) and positive ANC (c. 0.08 meq/l) occurred. At SE15 and 16, DOC was 7 and 8 mg/l, respectively. Acidity correlated rather well with aluminium being low in stream water at SE16 but higher in the more acid streams with pH c. 4.5 and Al-tot of 0.5-0.9 mg/l.

Nitrogen

Nitrogen deposition, varying from c. 10 kg/ha/year in the south to c. 4 kg/ha/year in the north is mainly retained in the catchments with the leaching being low and dominated by organic fractions making up 86-96% of the total N. In the more organic-rich stream waters of SE04 and 14, the organic-N was around 0.5-0.6 mg/l, while in the less organic-rich waters it was slightly over 0.3 mg/l.

In 1999 the leaching of nitrogen was 1.4-3.5 kg/ha/year, i.e. 30% of bulk deposition which is more than the years before when leaching was 10-20%. The inorganic fractions amounted to c. 0.1 kg NO_3-N/ha/year at all southern sites, apart from SE16 where inorganic-N was negligible. Leaching of NH_4-N was noteworthy at SE04, where it was as high as 0.6 kg/ha/year.

Methyl-Hg

A mishap occurred at SE04, where at a forest clear-cut operation outside the catchment, timber was transported through the upper part of the area. Thereby a forest road was established. This caused damaged soil surface and blocking the stream close to an outlet from a small peatland. Later actions were taken to reduce the effects of the damage. However, influence on the stream water chemistry was observed. Most elements were only altered slightly but those connected to organic material, such as metals, potassium and phosphorus changed. Most pronounced was the effect on mercury, especially methyl-Hg, which increased 100-fold, with the high level lasting for three months. Elevated levels around ten times, continued for at least one year. Such influence is severe as methyl-Hg exerts strong environmental impacts. However, further research is needed.

Vegetation changes

During 20 years of observations on a permanent plot at SE14, the tree canopy has closed gradually. The effect on vascular plants was mainly negative, light being reduced and root competition for water and nutrients increased. Mosses have increased their cover probably due to less competition and their smaller light demand. No changes attributable to pollutant deposition can be detected.

Crown defoliation at the three ICP IM sites studied (SE04, SE14 and SE15) was normal, i.e. around 20%. Tree biomass was biggest at the southernmost site (c. 200 ton/ha) and lowest at the northernmost (c. 100 ton/ha).

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Abstract	The Integrated Monitoring Programme (ICP IM) is part of the Effects Monitoring Strategy under the UN ECE Convention on Long-Range Transboundary Air Pollution. The main aim of ICP IM is to provide a framework to observe and understand the complex changes occuring in natural/ seminatural ecosystems. This report summarizes the work carried out by the ICP IM Programme Centre and several collaborating institutes. The emphasis of the report is in the work done during the programme year 2000/2001 including: - A short summary of previous data assessments - A status report of the ICP IM activities, content of the IM database, and the present geographical coverage of the monitoring network - Reports on the progress of priority topics of the ICP IM: - a progress report on the assessment of heavy metal stores and fluxes - a progress report on modelling understorey vegetation at a continental scale - a progress report on the assessment of fluxes and trends of S, N and base cations at ICP IM sites - a progress report on dynamic modelling of surface water and soil chemistry - Reports on national ICP IM activities.	
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Tiivistelmä	Yhdennetyn seurannan ohjelma (ICP IM) kuuluu YK:n Euroopan talouskomission (ECE) seurantaohjelmiin. Yhdennetyn seurannan ohjelmassa selvitetään kaukokulkeutuvien saasteiden ja muiden ympäristömuutosten vaikutuksia elinympäristöömme. Muutosten seurantaa ja ennusteita muutosten laajuudesta ja nopeudesta tehdään yleensä pienillä metsäisillä valuma-alueilla, mutta verkostoon kuuluu myös muita alueita. Tämä julkaisu sisältää koosteen ohjelmakeskuksen ja yhteistyölaitosten toiminnasta 2000/2001. Julkaisu sisältää: - Lyhyen koosteen aiemmin tehdyistä arvioinneista - Koosteen ICP IM ohjelman toiminnasta, kuvauksen seurantaverkosta ja ICP IM tietorekisterin sisällöstä - Tiivistelmät toiminnasta ohjelman painopistealueilla: - raskasmetallien varastojen ja ainevirtaamien määrittämisen tilannekatsauksen - suunnitelman arvioida kaukokulkeutumien aiheuttamia vaikutuksia aluskasvillisuuteen - typen ja rikin ainevirtaamien ja trendien määrittämisen tilannekatsauksen - dynaamisen mallintamisprojektin tilannekatsauksen - Kuvauksia kansallisesta ICP IM toiminnasta eri maissa.	
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Sammandrag	Programmet för Integrerad övervakning av miljötillståndet (ICP IM) är en del av monitoringsstrategin under UN ECE:s luftvårdskonvention (LRTAP). Syftet med ICP IM är att utvärdera komplexa miljöförändringar på avrinningsområden. Rapporten sammanfattar de utvärderingar som gjorts av ICP IM Programme Centre och de samarbetande instituten under programåret 2000/2001. Rapporten innehåller: - Sammandrag av programmets nuvarande omfattning och innehåll av IM databasen - Sammanfattning beträffande utvärderingar inom fyra prioriterade sektorer: - effekter av tungmetaller - inverkan av luftföroreningar på markvegetation - massbalanser och tidserier av S och N föreningar - modellberäkningar med dynamiska modeller - Beskrivning av nationella ICP IM aktiviteter.	
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